VOL. 5 NO. 8
April 30, 1980

Energy Research Abstracts

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UNITED STATES DEPARTMENT OF ENERGY

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ENERGY RESEARCH ABSTRACTS

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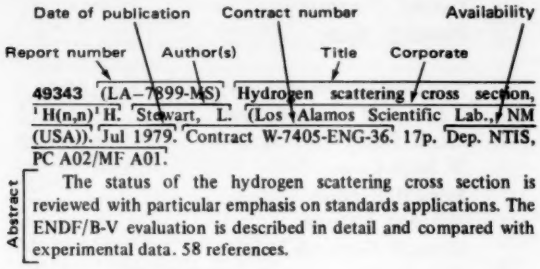
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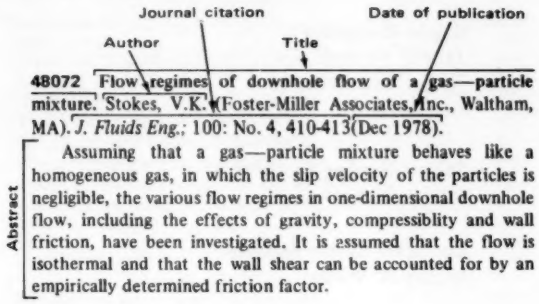
49343 (LA–7899-MS) Hydrogen scattering cross section, $^1H(n,n)^1H$. Stewart, L. (Los Alamos Scientific Lab., NM (USA)). Jul 1979. Contract W-7405-ENG-36. 17p. Dep. NTIS, PC A02/MF A01.
Abstract
The status of the hydrogen scattering cross section is reviewed with particular emphasis on standards applications. The ENDF/B-V evaluation is described in detail and compared with experimental data. 58 references.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Date of publication
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Title
48072 Flow regimes of downhole flow of a gas—particle mixture. Stokes, V.K. (Foster-Miller Associates, Inc., Waltham, MA). J. Fluids Eng.; 100: No. 4, 410-413 (Dec 1978).
Abstract
Assuming that a gas—particle mixture behaves like a homogeneous gas, in which the slip velocity of the particles is negligible, the various flow regimes in one-dimensional downhole flow, including the effects of gravity, compressiblity and wall friction, have been investigated. It is assumed that the flow is isothermal and that the wall shear can be accounted for by an empirically determined friction factor.

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is indexed as:

Los Alamos Scientific Lab., NM (USA)
Advanced laser fusion target fabrication research and development proposal, 4:48249 (LA–7619-P)
Hydrogen scattering cross section, $^1H(n,n)^1H$, 4:49343 (LA–7899-MS)
Low temperature physics and engineering. Quarterly progress report, January 1–March 31, 1979, 4:48988 (LA–7848-PR)

•Author Index

Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

Stewart, L., Hydrogen scattering cross section, $^1H(n,n)^1H$, 4:49343 (LA–7899-MS)
Stewart, M.D., *See* McInroy, J.F., 4:49280
Stewart, W., *See* Dean, J.W., 4:48543
Stimson, J., Reproduction, growth, and survival of Enewetak corals, 4:49200 (NVO–0703-1, pp 56-59)

•Subject Index

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

HYDROGEN 1 TARGET/NEUTRON REACTIONS
Hydrogen scattering cross section, $^1H(n,n)^1H$ (Above 100 keV, review), 4:49343 (LA–7899-MS)
HYDROGEN NITRATES
See NITRIC ACID
HYDROLOGY/RESEARCH PROGRAMS
Inventory of advanced energy technologies and energy conservation research and development: 1976-1978. Volume II. Prepared for the Committee on Science and Technology, U.S. House of Representatives, Ninety-Sixth Congress, 4:48749

•Contract Number Index

DOE technical report literature is indexed using contract numbers. This index contains the contract number with corresponding abstract and report numbers.

W-7405-ENG-36	**Los Alamos Scientific Lab., NM (USA)**	
	3:49698	LA-tr–78-45
	3:49857	LA–7224T
	3:49863	LA–7235-MS
W-7405-ENG-48	**California Univ., Livermore (USA). Lawrence Livermore Lab.**	
	3:49386	UCRL–52456
	3:49431	UCRL–52405

•Report Number Index

Technical report literature is also indexed using report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

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ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

11033 (ORNL—5612) **Fossil Energy Program. Quarterly progress report for the period ending September 30, 1979.** McNeese, L.E. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 347p. Dep. NTIS, PC A15/MF A01.

This quarterly report covers the progress made during the period June 30 through September 30 for the Oak Ridge National Laboratory research and development projects that are carried out in support of the increased utilization of coal and other fossil fuel alternatives to oil and gas as sources of clean energy. These projects are supported by the DOE Divisions of Fossil Fuel Processing, Fossil Fuel Utilization, Fossil Fuel Extraction, Planning and Systems Engineering, Basic Energy Sciences, Office of Health and Environmental Research, Office of Environmental Compliance and Overview, and by the Tennessee Valley Authority and the EPA Office of Research and Development through interagency agreements with the DOE.

11034 (ORNL/TM—7171) **Fossil Energy Program. Progress report for November 1979.** (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 74p. Dep. NTIS, PC A04/MF A01.

This report - the sixty-fourth of a series - is a compendium of monthly progress reports for the ORNL research and development programs that are in support of the increased utilization of coal and other fossil fuel alternatives to oil and gas as sources of clean energy. The projects reported this month include those for coal conversion development, materials engineering, a coal equipment test program, an atmospheric fluid bed combustor for cogeneration, engineering studies and technical support, process and program analysis, environmental assessment studies, magnetic beneficiation of dry pulverized coal, technical support to the TVA fluid bed combustion program, coal cogeneration/district heating plant assessment, chemical research and development, and technical support to major liquefaction projects.

PROCESSING

REFER ALSO TO CITATION(S) 11367

11035 (DOE/EIA—0121/8-10(78)) **Coke and coal chemicals, August-October 1978.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Nov 1978. 16p. Dep. NTIS, PC A02/MF A01.

This monthly report contains tables and graphs which present data for production, month-end producers' stocks, days' supplies, sales, disposal, and other industry trends for oven-coke, for beehive coke, for coke breeze, for pig iron, and for coal chemical materials in the United States. Data are for the most recent month, the previous month of the current year, the corresponding month of the previous year, and the calendar year-to-date of the current and the previous year. Production is tabulated for nineteen coal states, and coke and pig-iron production is shown for merchant plants and for furnace plants. Other industry trends include coke shipments by rail, coke exports and imports, coke prices in fourteen cities, and coal-chemical material prices. Some data are revised. A short narrative section highlights trends in the industry. Statistics are given for August, September, and October 1978.

CARBONIZATION

11036 (NTIS/PS—79/0477) **Coke manufacture (citations from the Engineering Index data base). Report for 1974-April 1979.** Hundemann, A.S. May 1979. 217p. NTIS PCN01/MF N01.

Coke production from bitumens, coal, petroleum and lignite is covered in this compilation from worldwide research. Studies on coke oven design, performance, corrosion, and deterioration are cited. Blast furnace coke, additives, quality control, and chemical analysis are discussed. Byproduct recovery from coking processes is included. (This updated bibliography contains 210 abstracts, 61 of which are new entries to the previous edition.)

11037 **Apparatus for producing blast furnace coal.** Weber, H.; Dungs, H.; Urbye, K.; Beckmann, F.; Schmauch, H.; Flasche, K.H. (to Firma Carl Still). US Patent 4,158,550. 19 Jun 1979. Filed date 6 Mar 1978. 6p.

A method of producing blast furnace coke from bituminous coals, particularly coals having poor coking capacities in which the coal to be carbonized is ground, predried or preheated, mixed with binders, compressed or formed into briquets having small mechanical resistances and charged into oven chambers, is characterized by fine coals or fine coal mixtures having a swelling index in mixture according to DIN 51741, smaller than 7, and preferably, below 6, and comprising more than 50% of poorly or non-baking coal having a content of volatile matter in excess of 30% or less than 20% which coals or coal mixtures are ground up to attain a surface per unit mass, according to DIN 66145, of from 400 cm^2 to 1200 cm^2 per gram, with from 3% to 8% by weight of organic binders, compressing the mixture to form it into a briquet at a temperature range of from 70°C to 300°C and charging the compressed briquet into the oven chambers without substantial intermediate cooling in order to carbonize it.

11038 **Granular activated carbon manufacture from sub-bituminous coal treated with dilute inorganic acid: direct activation method.** Murty, H.N. (to Carborundum Co.). US Patent 4,157,314. 5 Jun 1979. Filed date 6 Mar 1978. 14p.

Granular activated carbon is manufactured from subbituminous coal by crushing and screening the as received coal containing about 10 to about 25% moisture by weight to produce 8/30 mesh granules, treating the granules with a dilute aqueous solution of inorganic acid at a concentration from about 1 to about 25% by weight to reduce the volatile content and thereby increase the fixed carbon content. The particular concentration is selected to provide the desired activity and porosity of the activated carbon. The granules are then mixed with the acid, the acid is washed off, and the granules are at least partially dried to a moisture content below about 25% by weight. The granules are mixed with from 0 to about 15% by weight of coal tar pitch. The so treated granules are ground to form fine powder of not less than about 60% by weight -325 mesh, preferably more than about 65% by weight -325 mesh, which is compressed into shapes, such as pellets or thin corrugated sheets under high pressure, and then granulated to reform 6/20 mesh granules. These reformed granules are then directly activated, without prior charring and devolatilization, by directly heating to and at a temperature higher than the devolatilizing temperature in an atmosphere containing a gaseous activating agent.

11039 **Process for wet carbonizing of peat.** Myreen, B. (to Ra Shipping Ltd.). US Patent 4,153,420. 8 May 1979. Priority date 19 Apr 1977, Finland, 6p.

A process for the wet carbonizing of peat, wherein the peat is diluted and screened to become a raw peat suspension in a suspension preparing apparatus, the peat suspension thus obtained is preheated in series-connected heat exchangers and in a preheating tower, the preheated suspension is wet carbonized in a reactor into which steam is introduced from a steam boiler, the wet carbonized

peat suspension is cooled inthe preheating tower, mechanically dewatered in a dewatering apparatus and dried in a drying apparatus with the aid of hot drying gas, the exhaust gases from the boiler being employed as drying gas in the drying apparatus and the dust and water vapor containing exhaust gas emerging from the drying apparatus being purified and cooled in a wet separator, wherein part of the water vapor in the exhaust gas condenses and wherein there is used as washing water, polluted water coming from the dewatering apparatus and being cooled by heat exchange with the raw peat suspension in the heat exchanger, and the dust-laden and heated drain water from the wet separator being used as dilution water in the suspension preparing apparatus.

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 11085, 11086, 11087, 11106

11040 (FE—1517-T68) **Coal liquefaction and deashing studies of the CSF and SRC processes.** Kleinpeter, J.A.; Jones, D.C.; Dudt, P.J.; Burke, F.P.; Rutledge, G.D.; Rice, C.H. (Conoco Coal Development Co., Library, PA (USA). Research Div.). Nov 1978. Contract EX-76-C-01-1517. 297p. Dep. NTIS, PC A13/MF A01.

Continuous bench-scale studies on the deashing of coal liquefaction products by gravity settling were conducted in a 10 lb coal/hour unit. The donor solvent Consol Synthetic Fuel (CSF) process and the Solvent Refined Coal (SRC) process were simulated. Steady-state liquefaction solvents were used to give as good a simulation as possible. The SRC data were used in a conceptual design for the solvent deashing unit of a commercial coal liquefaction plant. Anti-solvent (deasphalting or precipitating solvent) screening was done in a batch system before continuous runs using anti-solvent were made. Deashed CSF product contained 0.22 wt % ash; using anti-solvent did not improve settling efficiency. The upflow velocity of the settler was 0.3 in/min, which is about 25% of the value obtained in a previous study using non-steady-state liquefaction solvent. SRC with 0.1 wt % ash was produced using an anti-solvent/liquefaction solvent weight ratio of 0.3 to 0.5. The recovery of SRC was 85% in this single-stage operation. The upflow velocity was 0.4 in/min. Deashing was sensitive to the amount of Soltrol 130 (a paraffinic naphtha) used as anti-solvent. Equilibrium liquefaction solvent from the Ft. Lewis SRC pilot plant was used. Performance of the 10 lb/hr liquefaction reactor matched Ft. Lewis results. Moderate contamination of recycled Soltrol 130 significantly decreased the settling rate. Kauri-butanol value was a good indicaton of anti-solvent purity. A conceptual design of a two-stage solvent deashing unit for a commercial (20,000 TPSD) SRC plant shows that thirty-five 40′ diameter primary settlers (600°F, 77 psig) and twenty wash settlers (550°F, 54 psig) of the same diameter are required to produce specification SRC (0.18% ash). The SRC recovery in the two-stage system is estimated at 97% of the entering SRC.

11041 (FE—2028-14-T6) **Kinetics and mechanism of desulfurization and denitrogenation of coal-derived liquids. Twelfth quarterly report, March 21-June 20, 1978.** Gates, B.C.; Katzer, J.R.; Olson, J.H.; Kwart, H.; Stiles, A.B. (Delaware Univ., Newark (USA). Dept. of Chemical Engineering; Delaware Univ., Newark (USA). Dept. of Chemistry). 20 Oct 1978. Contract EX-76-C-01-2028. 67p. Dep. NTIS, PC A04/MF A01.

All the data reported previously have been reevaluated to determine the quantitative reaction network for dibenzothiophene hydrodesulfurization at about 100 atm and 300°C. This network shows the high selectivity of the catalyst for simple hydrodesulfurization (biphenyl + H_2S formation). When methyl groups are present in the 4 and 6 positions of dibenzothiophene, the primary hydrogenation reaction is approximately as fast as the primary hydrodesulfurization reaction. Ni and Mo or Ni and W used instead of Co and Mo in the catalyst, or H_2S in the reactant mixture, also favor hydrogenation relative to hydrodesulfurization. Previous results have been evaluated in light of the recent literature to provide a new interpretation of the reaction mechanism of catalytic hydrodesulfurization on surfaces of sulfided Co-Mo/Al_2O_3. It has often been assumed that catalytic hydrodesulfurization of thiophene and related compounds proceeds via a one-point end-on adsorption involving bonding of the sulfur atom with Mo ions at an anion vacancy on the catalyst surface. This interpretation is inadequate, failing to account for deuterium-exchange results, the reactivities of benzothiophene and dibenzothiophene, and the small steric effects of methyl substituents affecting the adsorption and reaction of compounds in the thiophene, benzothiophene, and dibenzothiophene families of homologs. An alternative mechanism, presented, here, involves a multipoint adsorption of the reactant, with a C=C bond interacting with the Mo cation and the S atom of the reactant interacting with a S ion on the surface. The new mechanism accounts for the observed deuterium exchange and hydrodesulfurization reactions and is consistent with the observed steric effects.

11042 (FE/EES—79/8) **Economic evaluation of the coal oxydesulfurization process: one unit train per day of coal.** Morel, W.C.; George, T.J. (Department of Energy, Morgantown, WV (USA). Process Evaluation Office). Jun 1979. 30p. Dep. NTIS, PC A03/MF A01.

The chemical coal cleaning process, Oxydesulfurization, being developed at the Pittsburgh Energy Technology Center, has been evaluated. A flowsheet for an 11,845-ton-per-day commercial plant has been used as the basis for a preliminary cost study made by the Process Evaluation Office of the Department of Energy. The coal is from the Lower Freeport seam, and the cleaned coal product will meet the May 1978 EPA standards on sulfur emissions for new steam powerplants. Results of the cost study indicate processing charges of $20.43, $23.37, and $28.66 per ton of product assuming 12-, 15-, and 20-percent discounted cash flows (DCF) and 100 percent equity financing. With 33:67 debt-equity financing, again assuming 12-, 15-, and 20-percent DCF rates, the processing charges are $18.47, $20.41, and $23.92, respectively.

11043 (FE/EES—79/9) **Economic evaluation of the modified coal oxydesulfurization process: one unit train per day of coal.** Morel, W.C.; George, T.J. (Department of Energy, Morgantown, WV (USA). Process Evaluation Office). Jun 1979. 29p. Dep. NTIS, PC A03/MF A01.

The chemical coal desulfurization process, Oxydesulfurization, developed at the Pittsburgh Energy Technology Center, has been modified to include gravity separation of the coal slurry so that only 45 percent of a Lower Freeport coal with favorable characteristics needs to be chemically treated to meet EPA standards in effect May 1978. A flowsheet for a commercial plant to produce 11,740 tons per day of product has been developed and is used as a basis for a preliminary cost study made by the Process Evaluation Office of the Department of Energy. Results of the cost study indicate processing charges of $16.16, $18.49, and $22.69 per ton of product assuming 12-, 15-, and 20-percent discounted cash flows (DCF) and 100 percent equity financing. With 33:67 debt-equity financing, again assuming 12-, 15-, and 20-percent DCF rates, the processing charges are $14.61, $16.51, and $18.93, respectively.

11044 (ISM—247) **Pyrite desulfurization by wet oxidation in alkaline solutions.** Chuang, K.C.; Chen, M.C.; Greer, R.T.; Markuszewski, R.; Sun, Y.; Wheelock, T.D. (Ames Lab., IA (USA)). 1979. Contract W-7405-ENG-82. 26p. (CONF-791108—14). Dep. NTIS, PC A03/MF A01.

From 72. AICHE meeting; San Francisco, CA, USA (25 Nov 1979).

Particles of iron pyrites can be desulfurized by leaching them with a hot alkaline solution containing dissolved oxygen under pressure. As the reaction proceeds, sulfur is extracted largely as soluble sulfates and a shell of iron oxide is formed around a shrinking core of pyrite. The overall rate of the reaction seems to be controlled by diffusion of dissolved oxygen through the shell of iron oxide.

11045 (PB—290515) **Bench scale development of Meyers process for coal desulfurization. Final report, November 1975-October 1977.** Meyers, R.A.; Koutsoukos, E.P.; Santy, M.J.; Orsini, R. (TRW Systems Group, Redondo Beach, CA (USA)). Jan 1979. Contract EPA-68-02-2121. 104p. NTIS, PC A06/MF A01.

The report gives results of coal desulfurization experiments to determine the feasibility and advantages of combining gravity separation of coal with chemical desulfurization. The investigations led to the definition of the Gravichem Process, a combination physical/chemical coal desulfurization scheme involving Meyers Process reagent and chemistry. Two coals were investigated: a run-of-the-mine coal sample and a mine-cleaned (MC) coal sample, both from the Martinka Mine, Lower Kittanning seam, and furnished by the American Electric and Power System (AEP Utility). Coal selection was influenced by the 60 million tons of recoverable Martinka Mine coal reserves, by the availability of coal output from a modern, commercial size, physical coal cleaning plant at the same mine, and by AEP's expressed interest in physical and chemical coal desulfurization as a means of solving sulfur pollution problems. MC Martinka coal will be the first coal to be tested at the 8 tons per day Meyers Process Reactor Test Unit.

11046 (UCRL—83614) **Laser cleanup of H_2S from synthesis gas.** Chen, H.L.; Borzileri, C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Jan 1980. Contract W-7405-ENG-48. 16p. (CONF-791220—4). Dep. NTIS, PC A02/MF A01.

From International conference on lasers '79; Orlando, FL, USA (17 Dec 1979).

Hydrogen sulfide at the 10 ppM level has been selectivity stripped from a CO + H_2 synthesis gas by photolysis with an ArF laser. The sulfur in the atomic or radical form is irreversibly removed by a metal surface. Spectroscopic and quantum yield data are presented. An H_2S spectroscopic selectivity $> 10^3$ was measured in the 210 to 220 nm range, a wavelength range compatible with Raman-shifted ArF or KrF lasers. The laser purification method

described here is a potential practical approach to achieve sulfur impurity levels < 0.1 ppM. This method is of potential industrial significance for extending the lifetime of syngas metal catalysts.

11047 Process for removing sulfur from coal. Burk, E.H. Jr.; Yoo, J.S.; Karch, J.A. (to Atlantic Richfield Co.). US Patent 4,158,548. 19 Jun 1979. Filed date 15 Mar 1978. 12p.

A process is described for reducing the pyritic sulfur content of coal comprising: (1) contacting coal particles with an aqueous solution of iron complexing agent, and an oxidant; and (2) recovering coal particles of reduced sulfur content.

11048 Process for removing sulfur from coal employing aqueous solutions of sulfites and bisulfites. Sun, J.Y.; Yoo, J.S.; Burk, E.H. Jr. (to Atlantic Richfield Co.). US Patent 4,155,717. 22 May 1979. Filed date 3 Jan 1978. 6p.

A process for reducing the sulfur content of coal comprising the steps of: (1) contacting coal particles with an aqueous solution of compositions selected from the group comprising alkali metal and alkaline earth metal sulfites and bisulfites to reduce the sulfur content of the coal; and (2) recovering coal particles of reduced sulfur content.

11049 Process for removing sulfur from coal. Sun, J.Y.; Yoo, J.S.; Burk, E.H. Jr.; Masologites, G.P. (to Atlantic Richfield Co.). US Patent 4,155,716. 22 May 1979. Filed date 3 Jan 1978. 8p.

A process for reducing the sulfur content of coal comprises the steps of: (1) contacting coal particles with a silicate selected from the group consisting of alkali metal silicates, alkaline earth metal silicates and mixtures thereof in an aqueous medium to reduce the sulfur content of the coal; and (2) recovering coal particles of reduced sulfur content.

11050 Process for reducing the organic sulfur content of char. Sass, A.; Bauer, H.F.; Green, N.W. (to Occidental Petroleum Corp.). US Patent 4,155,715. 22 May 1979. Filed date 6 Sep 1977. 4p.

This invention covers an improved hydrodesulfurization process which significantly reduces the organic sulfur content of char by first magnetically or electrostatically removing iron sulfides and precursors of iron sulfides from char and then hydrodesulfurizing the remaining char.

11051 Coal desulfurization using alkali metal or alkaline earth compounds and electromagnetic irradiation. Zavitsanos, P.D.; Bleiler, K.W.; Golden, J.A. (to General Electric Co.). US Patent 4,152,120. 1 May 1979. Filed date 6 Feb 1978. 8p.

Pyritic and organic sulfur is removed from pulverized coal by contacting the coal with an alkali metal or alkaline earth compound and thereafter using low amounts of electromagnetic energy to preferentially heat sulfur rich regions of the coal-alkali compound mixture. The alkali compound reacts with the sulfur within the coal to form water soluble, or separated compounds of sulfur which can easily be removed by washing the treated coal with water and/or to form compounds which do not convert into sulfur oxides during combustion of the coal.

HYDROGENATION

REFER ALSO TO CITATION(S) 11086

GASIFICATION

REFER ALSO TO CITATION(S) 11033, 11835, 11883

11052 (CONF-800305—2) **Materials testing at the Hanna IV in situ coal gasification site.** Keefer, D.W.; Scoonover, T.M. (EG and G Idaho, Inc., Idaho Falls (USA); Climax Molybdenum Co. of Michigan, Ann Arbor (USA)). 1980. Contract EY-76-C-07-1570. 28p. Dep. NTIS, PC A03/MF A01.

From Corrosion/80 NACE meeting; Chicago, IL, USA (6 Mar 1980).

Candidate structural alloy specimens were exposed for about 800 hours to the direct product gas stream from the Hanna IV underground coal gasification experiment. When the specimens were removed from the line, they were coated with a high-sulfur deposit from the product gas. A chemical analysis and the physical appearance of the coatings suggest that they are mixtures of condensed hydrocarbons, coal char, coal ash, and mineral particles from the overburden. Attack on the specimens was primarily corrosion rather than erosion. Mean penetration rates expressed in millimetres per year (mm/y) were calculated from weight loss data. Microscopic examination revealed areas of rather severe local attack on all alloys tested. There was no consistent difference in the amount of material removed from specimens with welds and those without welds. All specimens exposed at 45° to the product gas flow had surface dents from impacting particles, while parallel specimens had none. Energy-dispersive X-ray and Auger electron spectra indicate that the few particles of deposits and/or corrosion products still clinging to the specimen surfaces after cleaning were oxides, rather than sulfides, with significant contents of aluminum and silicon in addition to iron.

11053 (COO—4375-1) **Improved water management of coal conversion processes by preliminary absorption of halides.** (McKee (Davy) Engineers and Constructors, Cleveland, OH (USA)). Dec 1979. Contract EE-77-C-02-4375. 180p. Dep. NTIS, PC A09/MF A01.

For coal conversion processes that employ wet cleaning of gases, such as those supplying cooled gas to storage or to distribution systems, gas condensates are produced that contain various pollutants. Condensates from gases derived from coal may contain gas borne particulates, tars, oils or water solubles such as ammonia, chlorides, cyanides, fluorides, phenols and sulfides. The upgrading of contaminated gas condensates to service water quality by treatment oriented technology can entail a complex sequence of processing including desalination. A modified wet gas cleaning system was proposed by Davy McKee Corporation as offering promise of improving the practicality of reuse of gas condensates from coal gasification. This production oriented technology replaced the conventional single stage quench of the gases with a system incorporating a two-stage quench. The concept advocated the removal of particulates and the absorption of halides and other strong electrolytes in a controlled first stage quench that would condense a small fraction of the water vapor contained in the product gas. This low volume primary condensate would be purged from the system. The major fraction of condensate collected by the second stage quench would be relatively free of strong electrolytes and would be amenable to processing for reuse without resort to desalination technology. The volatile weak electrolytes in the secondary condensate would be removed by steam stripping and organic substances would be removed by biological treatment. The proposal is more advantageous with coals containing more than average amounts of chlorides.

11054 (DOE/ET/13108—2) **Appendices to site qualification studies of the UCG/SDB Site, North Knobs, Wyoming.** (Gulf Research and Development Co., Pittsburgh, PA (USA)). 1979. Contract EF-77-C-03-1472. 341p. Dep. NTIS, PC A15/MF A01.

11055 (FE—1207-T8) **Gas generator research and development, BI-GAS process. BI-GAS Pilot Plant gasifier operation tests G-7 and G-7A.** (Bituminous Coal Research, Inc., Monroeville, PA (USA); Phillips Petroleum Co., Homer City, PA (USA)). Oct 1979. Contract EF-77-C-01-1207. 48p. Dep. NTIS, PC A03/MF A01.

The BI-GAS Pilot Plant, located in Homer City, Pennsylvania, is designed to study a new process for the conversion of coal to pipe-line quality gas. The BI-GAS process was developed through work performed by Bituminous Coal Research, Inc., under contract with the US Office of Coal Research. This is the eighth of a series of operating reports designed to describe pilot plant activities, present data and conclusions, and to make recommendations. This report focuses on the operation of the 2-stage, entrained-bed, high pressure (1500 psig max), oxygen blown, and ash slagging gasifier during two separate tests (G-7 and G-7A). Subbituminous coal from the Rosebud seam of the Western Energy Company's mine at Colstrip, Montana, was fed to Stage II of the gasifier during each test. The two tests were conducted between February 4th and February 25th, 1978, and included a total of only 17 hours of coal feed and 7.5 hours of char feed. Both tests were very sporadic, being plagued by cold weather which resulted in frozen process and sensing lines. Therefore, none of the overall objectives were achieved, but several specific conclusions can be drawn from the limited operation that was achieved. This series of tests was terminated when A char burner ruptured. The gasifier rapidly depressured through the rupture and a fire ensued. Extensive damage was sustained by the electrical wiring, controls, and insulation in the gasifier structure. Total damage was approximately $42,350 with repairs taking about five months.It is becoming increasingly apparent that a new char burner design is needed to eliminate the plugging tendencies, damaged burner faces, and premixing of fuel and oxygen, all of which have been experienced several times.

11056 (FE—1207-T12) **Gas generator research and development, BI-GAS process. On-stream gas analysis.** (Bituminous Coal Research, Inc., Monroeville, PA (USA); Phillips Petroleum Co., Homer City, PA (USA)). Oct 1979. Contract EF-77-C-01-1207. 25p. Dep. NTIS, PC A02/MF A01.

The BI-GAS Pilot Plant, located in Homer City, Pennsylvania, is designed to study a new process for the conversion of coal into pipeline quality gas. The most tangible result and the most important objective of the BI-GAS Pilot Plant has been to build a data base from which economic, process and environmental evaluations can be made. Commercialization is based on those evaluations. It is therefore, necessary to attain a reliable and accurate on-stream gas analysis because it plays a big part in building that data base. Efforts to do that required solving several problems in sampling techniques and analyzing procedures. Five major problems surfaced as a result of the development work in on-stream gas analysis. Three that were solved successfully were accurate and reliable hydrogen

and water concentration determinations, and high pressure and temperature sampling of a dirty gas. One of the problems that still needs work is in the area of chromatographic analysis of ammonia and hydrogen sulfide. Separation of the gasification products is not yet clean and therefore an accurate concentration determination not yet possible. The other problem still unresolved is in the sampling of the gas washer overhead line. Except for analyzing for ammonia in the presence of hydrogen sulfide, the analysis of all streams are accurate enough for use in material and energy balances and for control of plant operation.

11057 (FE—1207-T13) **Gas generator research and development, BI-GAS process. A study of ammonia consuming bacteria.** (Bituminous Coal Research, Inc., Monroeville, PA (USA); Phillips Petroleum Co., Homer City, PA (USA)). Oct 1979. Contract EF-77-C-01-1207. 23p. Dep. NTIS, PC A02/MF A01.

One of the problems encountered in operating the BI-GAS Pilot Plant has been the excessive production of ammonia in the synthesis gas from the gasifier. The contract with the Indiana Borough Sewage Plant limits the concentration of ammonia nitrogen in the wastewater to 25 ppM and total kjeldahl nitrogen to 50 ppM. This report presents some of the problems encountered at the BI-GAS Pilot Plant with ammonia removal from the plant wastewater and the results of a study to consider use of ammonia-consuming bacteria for that purpose. Nitrobac, a special strain of ammonia-consuming bacteria from Polybac Corporation and baker's yeast, were studied for their ability to remove ammonia from plant wastewater. The organism in baker's yeast consumes ammonia nitrogen and uses it in the formation of amino acids in the production of cell materials. Nitrobac, on the other hand, is a nitrifying bacteria and according to Polybac Corporation, is supposed to use ammonia nitrogen as an energy source while converting it to nitrites and nitrates, thus reducing ammonia nitrogen and total kjeldahl nitrogen. Total kjeldahl nitrogen is the sum of inorganic (NH_3) and organic nitrogen (amines, etc.), but not nitrate or nitrite nitrogen. The Nitrobac received, did not perform as claimed in converting ammonia to nitrates and nitrites. It was later discovered that a contaminant was consuming ammonia nitrogen in much the same way as yeast.Nitrobac and yeast both consumed ammonia nitrogen, possibly in synthesizing amino acids, only after the addition of various nutrients. In all experiments the total nitrogen remained at a constant level. Since there is also a total kjeldahl nitrogen limitation of 50 ppM for the BI-GAS effluent, this approach to the ammonia removal problem is not recommended. If further study of bacterial removal of ammonia is desired, Nitrosomonas and Nitrobacter bacteria should be obtained in pure cultures for laboratory evaluation.

11058 (FE—1207-T15) **Gasifier burner ignition system.** (Bituminous Coal Research, Inc., Monroeville, PA (USA); Phillips Petroleum Co., Homer City, PA (USA)). Oct 1979. Contract EF-77-C-01-1207. 193p. Dep. NTIS, PC A09/MF A01.

The BI-GAS pilot plant is designed such that its lower region (Stage I) is the combustion zone where oxygen and steam contact and react with recycled char. As with other combustion systems, provisions must be made to initiate combustion at start-up, to reinitiate combustion in case of a process upset where combustion is lost, and to continuously monitor the presence of combustion. An ignition system had to be developed, capable of reliable and repeated operation at pressures up to 1500 psi in a methane-rich or otherwise reducing atmosphere. The initial development work was done by Babcock and Wilcox and included development of both the ignitor system and the flame confirmation system. B & W's initial proposal specifically dealt with investigating a hypergolic (chemical autocombustion) igniter. Hypergolic ignition is the spontaneous combustion of a compound upon contact with an oxygen containing media. This oxygen source includes air, oxygen, carbon dioxide, and water. The liquid compound studied was triethylaluminum ($Al[C_2H_5]_3$) otherwise identified as TEA and supplied by Ethyl Corporation, Baton Rouge, Louisiana. The hypergolic ignition system has been operated successfully and proved reliable at high pressure (750 psig) through repeated testing over a three-year period. The system designed by Stearns-Roger based on the study by Babcock & Wilcox was basically correct. Two relatively minor design defects and operational revisions to improve performance were accomplished by on-site personnel with little expenditure of time or money. The remaining problems currently experienced with the TEA ignition system are considered minor. Further work should continue to determine the lowest possible TEA concentration that can be used and still provide consistent ignition, and the system should be tested soon at the full design operating pressure of 1500 psig.

11059 (FE—1207-T16) **Gas generator research and development, BI-GAS process. A study of flame detection devices in a high pressure gasifier.** (Bituminous Coal Research, Inc., Monroeville, PA (USA); Phillips Petroleum Co., Homer City, PA (USA)). Oct 1979. Contract EF-77-C-01-1207. 21p. Dep. NTIS, PC A02/MF A01.

A principal feature of the BI-GAS Pilot Plant is the 2-stage, entrained-bed, high pressure (1500 psig max), oxygen blown, and ash slagging gasifier unit constructed by the Babcock and Wilcox Company. The gasifier is designed such that its lower region (Stage I) is the combustion zone where oxygen and steam contact and react with recycled char. As with other combustion systems, provisions must be made to initiate combustion at start-up, to reinitiate combustion in case of a process upset where combustion is lost, and to continuously monitor the presence of combustion. An ignition system had to be developed, capable of reliable and repeated operation at pressures up to 1500 psi in a methane-rich or otherwise reducing atmosphere. The initial development work was done by Babcock and Wilcox and included development of both the ignitor system and the flame confirmation system. One of the problems encountered in operating the BI-GAS Pilot Plant has been unreliable flame detection of the pilot burners in the high pressure gasifier. Since the operation of the slag tap burner (STB) and the slag heating burner (SHB) are prerequisites for the gasifier start-up as well as prolonged operation, verification of a flame is important to the pilot plant operation. The original Bailey Meter Company's Flamon ultraviolet detector had not provided that reliability as evidenced by numerous shutdowns of the gasifier.This report presents the findings of a study aimed at evaluating several alternate commercially available flame detection devices with hopes of finding one capable of doing the job. An infrared Fireye flame detector made by Electronics Corporation of America showed very encouraging results. As a result, the Fireye was recommended and installed as the flame detection device on both pilot burners has proven superior to any of the ultraviolet detectors.

11060 (FE—1207-T17) **Gas generator research and development BI-GAS process. Economics of gasifier effluent recycle gas to Stage I of a BI-GAS Pilot Plant.** (Bituminous Coal Research, Inc., Monroeville, PA (USA); Phillips Petroleum Co., Homer City, PA (USA)). Oct 1979. Contract EF-77-C-01-1207. 17p. Dep. NTIS, PC A02/MF A01.

The BI-GAS gasifier is designed such that its lower region (Stage I) is the combustion zone where oxygen and steam contact and react with recycled char. One of the problems encountered has been the safe and efficient combustion of char. Since there does not exist a reliable solids flow measurement device capable of withstanding high pressure (1500 psig max) high temperature (800°F) operation in this particular char feed system, oxygen feed cannot be regulated with any degree of accuracy. Steady combustion cannot therefore be assured. When combustion experts were asked to evaluate this situation, they felt comfortable that reignition of char in Stage I (the lower combustion zone of a two-stage, entrained-bed, ash slagging gasifier) would occur. They did fear, however, detonation or temperature excursions in Stage II of the gasifier (the upper coal devolilization zone) if coal combustion was initiated. Their recommendation therefore was to maintain a supplemental fuel gas feed to the char burners to burn all of the oxygen feed until a reliable char flow measurement device was developed and tested. That development work is under way. This report presents an economic analysis of various recycle gas supplemental fuels in comparison to a study done by C.F. Braun which used no fuel gas addition to Stage I of the gasifier. The results indicate that, should a supplemental fuel be necessary to provide stable combustion and/or temperature control, a gasifier effluent recycle gas with all of the water, H_2S, and carbon dioxide removed, would be the most economical choice.It would increase the final cost of the substitute natural gas by only 9.4%. Before a commercial plant is designed incorporating this recycle gas supplemental fuel, a further and more detailed economic evaluation should be performed.

11061 (FE—2030-TR14) **Reactivity of heat treated coals in steam.** Linares-Solano, A.; Mahajan, O.P.; Walker, P.L. Jr. (Pennsylvania State Univ., University Park (USA). Coal Research Section). Apr 1979. Contract EX-76-C-01-2030. 24p. Dep. NTIS, PC A02/MF A01.

Reactivities of seventeen 40 x 100 mesh US coals charred to 1000°C have been measured at 910°C in 0.1 MPa of a N_2-H_2O mixture containing water vapor at a partial pressure of 2.27 kPa. Char reactivity decreases, in general, with increasing rank of the parent coal. The chars show a 250-fold difference in their reactivities. Results suggest that gasification of chars in air, CO_2 and steam involves essentially the same mechanism and that relative gasification rates are controlled by the same intermediate oxygen-transfer step. Removal of inorganic matter from raw coals prior to their charring or from chars produced from raw coals decreases the reactivities of lower rank chars whereas reactivities of higher rank chars increase. Addition of H_2 to steam has a marked retarding effect on char reactivity in most cases. However, in a few cases H_2 acts as an accelerator for gasification. The effect of particle size, reaction temperature and water vapor pressure on char reactivity is considered.

11062 (FE—2036-30) **Liquid Phase Methanation Pilot Plant operation and laboratory support work. Quarterly report, April 1-June 30, 1978.** (Chem Systems, Inc., New York (USA)). Aug 1978. Contract EX-76-C-01-2036. 81p. Dep. NTIS, PC A05/MF A01.

LPM Pilot Plant Run 6 using catalyst # 038-A was completed after 646 hours of on-stream time including 24 hours of methanation on HYGAS synthesis gas and 30 hours on steam-methane reformer gas. A wide range of process conditions were tested. Catalyst rate constants, initially higher than in previous runs, increased five-fold during the course of the run and CO conversion approached 100 percent. Initially, the catalyst remained as a packed bed, evidently due to bridging of the catalyst particles. However, the catalyst particles rapidly deteriorated until, by the end of the run, the system was performing as an entrained slurry reactor. The run was terminated when all major pump seals failed due to plugging with catalyst fines. During shutdown after Run 6, reactor internals were designed to alleviate some of the backmixing and distribution problems previously experienced. These internals consisted of vertical stainless steel tubes and a catalyst retention plate. After problems with main oil pump seals had been corrected, oil circulation was begun and catalyst was loaded into the reactor. Run 7 began with 2200 pounds of INCO-J catalyst (very much the same as INCO-H). Run 7 involved 32 hours of methanation time on reformer gas. The catalyst activity was similar to Runs 3 and 4. The run ended when a major fire occurred at the inboard filter during filter change. In the rates of carbon formation experimental program, ten runs were initiated.The conditions of all runs initiated to date are given. Spent catalysts from completed runs have been analyzed. Preliminary results indicate that carbon has been forming in all cases, even when the feed gas composition is outside the theoretical carbon forming region. Considerably more information will be necessary before these results can be accurately quantified.

11063 (FE—2218-31) **Improvement of the mechanical reliability of monolithic refractory linings for coal gasification process vessels. Quarterly progress report, January-March 1979.** Anderson, E.M. (Babcock and Wilcox Co., Alliance, OH (USA). Contract Research Div.; Babcock and Wilcox Co., Lynchburg, VA (USA). Materials and Chemical Technology Lab.). May 1979. Contract EX-76-C-01-2218. 46p. Dep. NTIS, PC A03/MF A01.

This, the eleventh quarterly report on this DOE program, summarizes the physical and mechanical property testing done on the metal fiber containing 50% Al_2O_3 dense refractory concrete and the results of three thermal cycles on Lining # 7 which contained this material. This lining cracked the least and had the best overall performance of any lining tested to date. The metal fibers are believed to be responsible for this improved performance. They make the dense component material more resistant to crack propagation and appear to make it act more uniformly to thermal and mechanical loading. The results suggest that more work should be done with this concept.

11064 (FE—2361-45(Vol.1)) **Development of fast fluid bed coal gasification process. Phase I, Volume 1. Final report, July 1976-April 1979.** (Hydrocarbon Research, Inc., Lawrenceville, NJ (USA)). Jul 1979. Contract EX-76-C-01-2361. 215p. Dep. NTIS, PC A10/MF A01.

The objective of this program, under Department of Energy Contract No. EX-76-C-01-2361, was to develop a coal gasification process for low Btu gas utilizing the principle of the fast fluid bed unit operation. The program encompassed four tasks: design, construction, operation and recommendations for further development. Program objectives were met within the contractual schedule. Cold flow fluid dynamic tests were conducted at City University of New York to provide a data base for the gasifier design. A cold test run initiated operation of the Fast Fluid Bed gasifier; three runs at design conditions followed. Two of the runs used anthracite feed coal and the third used Illinois No. 6, a caking coal. Gas production was achieved in all three runs - gas heating values of 130 Btu/SCF were reached in the Illinois coal run, and as high as 90 Btu/SCF were obtained during the anthracite operations. There were no plugging problems during any of these runs. In addition to low Btu gas, fast fluid bed technology can be used to generate medium Btu syngas (320 Btu/SCF) or high Btu gas (1000 Btu/SCF SNG), if desired. Perhaps its greatest technical and economic advantage is the production of low Btu gas for use in combination with advanced power cycles. While the fast fluid bed gasification concept is new, many of the basic concepts have been employed in other industries so that the prospects of successful development appear to be extremely high.

11065 (FE—2361-45(Vol.3)) **Development of a fast fluid bed coal gasification process: Phase I. Final report, July 1976-April 1979.** (Hydrocarbon Research, Inc., Lawrenceville, NJ (USA)). Jul 1979. Contract EX-76-C-01-2361. 137p. Dep. NTIS, PC A07/MF A01.

11066 (FE—2361-45(Vol.4)) **Development of a fast fluid bed coal gasification process. Volume 4. Appendix C. Run data summaries. Final report.** (Hydrocarbon Research, Inc., Lawrenceville, NJ (USA)). Jul 1979. Contract EX-76-C-01-2361. 165p. Dep. NTIS, PC A08/MF A01.

11067 (FE—2369-24) **Exxon Catalytic Coal Gasification Process Predevelopment Program. Final project report.** Kalina, T.; Nahas, N.C. (Exxon Research and Engineering Co., Baytown, TX (USA)). Dec 1978. Contract EX-76-C-01-2369. 377p. Dep. NTIS, PC A16/MF A01.

This report summarizes the results of work conducted on Predevelopment Research for the Exxon Catalytic Coal Gasification Process. The eighteen-month effort (July 1976-December 1977) was a coordinated program which included operation of a continuous fluidized-bed gasifier, parallel bench-scale research, and engineering studies leading to the preparation of a commercial-scale plant study design and economics for producing SNG from Illinois coal.

11068 (FE—2606-7) **Development of automated welding processes for field fabrication of thick-walled pressure vessels: electron beam method. Seventh quarterly report, April 1-June 30, 1979.** Weber, C.M. (Babcock and Wilcox Co., Alliance, OH (USA). Research and Development Div.). 1979. Contract EF-77-C-01-2606. 35p. Dep. NTIS, PC A03/MF A01.

A total of 449 experimental welds have been made to date. Partial penetration welding procedures capable of producing defect-free, 4-inch deep welds have been developed in the horizontal position. The travel speed that can be acceptably used for partial penetration welding of 2 1/4 Cr-1 Mo is larger for 6-inch thick plate than for 8-inch thick plate. Although defect-free welds can be made with soft vacuum conditions, hard vacuum conditions produce the most reliable performance. A procedure for welding an 8-inch thick joint has been developed. A small test plate was welded, radiographed, and cross sectioned and found to be acceptable. A large 8-inch thick test plate was welded and found to contain porosity. Difficulties in uniformly moving this large plate appear to be responsible for the porosity encountered. A mechanical modification to the welding equipment is being made and the large plate will be welded again. 3 figures.

11069 (FE—2806-4) **Coal gasification pilot plant support studies. Project 61015 quarterly report, January 1-March 31, 1979.** (Institute of Gas Technology, Chicago, IL (USA)). Sep 1979. Contract ET-78-C-01-2806. 143p. Dep. NTIS, PC A07/MF A01.

Seven additional isothermal devolatilization tests were made in a coiled-tube reactor with a Colorado subbituminous B coal at temperatures ranging from 800 to 1400°F in hydrogen and helium atmospheres at a total pressure of 500 psig. These tests showed a good agreement of CO and CO_2 yields with predicted values. To resolve the discrepancy in comparing heavy hydrocarbons (oils, tars, C/sub 3+/ exchuding C_6H_6) yields with the model, a direct measurement technique was developed, employing two Porapak Q packed columns connected in series. Preliminary chromatographic analysis of the packed column contents identified 20 to 30 types of hydrocarbon compounds. Further data analysis is in progress. The analyses of previous thermobalance gasification data with lignite chars indicate that gasification can be broadly divided into (a) rapid-rate, (b) transient-rate, and (c) low-rate gasification reactions. The kinetic parameters, including the effect of inherent catalytic constituents, for Montana, North Dakota, and Darco lignites were estimated. Experimental work to determine the effect of the addition of calcium and sodium on the gasification of bituminous coals is in progress. Detailed thermodynamic analysis of the steam generation process steps in the HYGAS Design B11-s were conducted to identify the causes of efficiency losses. Further analyses are in progress to define the basis for the observed irreversibilities and to explore efficient process alternatives. Three other studies are reported.

11070 (ORNL/TM—6587) **Survey of industrial coal conversion equipment capabilities: equipment operating experience, prices, and development programs.** Williams, W.R.; Horton, J.R.; Reed, W.R.; Boudreau, W.F. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 244p. Dep. NTIS, PC A11/MF A01.

Previous reports in this series have covered the capabilities of industry to supply equipment required for demonstration and commercial coal conversion facilities, primarily from the manufacturers' point of view. This report complements these earlier reports, particularly in the areas of rotating components (ORNL/TM-6074) and heat recovery (ORNL/TM-6073). Equipment operating experience in pilot plants supported by the Department of Energy is discussed; equipment price correlations, based on vendor price estimates and suitable for initial conceptual design cost estimating, are presented; and the scheduling and economics of equipment development programs are reviewed. Conclusions of the previous studies have generally been supported by this latter work. Centrifugal slurry pumps have performed poorly in the pilot plants; however, several single-stage centrifugal slurry pumps which incorporate features recommended by a number of manufacturers during FY 1977 are now being installed. Reciprocating pumps currently appear to be economically desirable for high-head slurry-pumping systems (above 600 psi, and perhaps lower), even when projected technological improvements are considered for both centrifugal and reciprocating machines. Prototypical oxygen and heat-transfer systems have not been used in pilot facilities; therefore much of the development that these systems will need must occur during the demonstration-plant phase.

11071 (PB—291912) **Studies toward improved techniques for gasifying coal. Final report, 1 June 1972-31 July 1976.** Graff, R.A.; Yerushalmi, J.; Squires, A.M. (City Coll., New York (USA). Dept. of Chemical Engineering). 1976. 303p. NTIS, PC A14/MF A01.

Studies have been conducted in the following five areas: high velocity fluidized beds; flash hydrogenation of coal; agglomerating fluidized beds; the Godel Phenomenon; and flowsheeting and system studies. A test stand with three fast beds, in heights of 23 and 24 feet, was constructed and instrumented. Research results have provided extensive data on the various regimes of fast fluidization and on design and operation of the fast bed and its components. The flash hydrogenation process of converting raw coal in one step to methane, ethane, and light aromatic liquids shows great promise. A bench scale reactor was developed for flash heating of coal providing independent control of heat rate, solids contact time, and vapor residence time. The mechanism of formation of low-carbon ash agglomerates was studied. Defluidization experiments were conducted at high temperature using various reactor solids. Evidence has been developed suggesting a strong relation between 'initial sintering temperature' as determined by dilatometry and stable fluid bed operation. Defluidization was also studied in beds of coarse particles to which sticky matter was added. Flowsheeting and system studies investigated the integration of low-BTU fuel gas generation with electricity generation using combined gas and steam turbines; the 'Energy Corridor' concept, which combines power transmission and storage by compressed air with district heating and air conditioning and storage of fuel gas; and the configurations of a 'Coalplex' producing methane, light liquids, and electricity from coal.

11072 (SAN—1429-40) **Molten Salt Coal Gasification Process Development Unit. Quarterly technical progress report No. 10, July-September 1978.** (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). 1 Nov 1978. Contract EF-77-C-03-1429. 23p. Dep. NTIS, PC A02/MF A01.

This tenth quarterly progress report on the Molten Salt Coal Gasification Process Development Unit (PDU) Project includes the design, construction, and operation of a PDU which will convert one ton of coal per hour into low-Btu gas. All construction administrative activities have been completed. Plant discrepancies noted during the construction to startup turnover review were resolved. All equipment and subsystems associated with the initial gasification run were checked out and are operational while startup checkouts of other plant equipment continues. A final safety analysis report was completed and issued.

11073 (SAN—1429-44) **Molten Salt Coal Gasification Process Development Unit. Quarterly technical progress report No. 11, October-December 1978.** (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). 25 Jan 1979. Contract EF-77-C-03-1429. 24p. Dep. NTIS, PC A02/MF A01.

This represents the 11th quarterly progress report on the Molten Salt Coal Gasification Process Development Unit (PDU) Project. The project includes the design, construction, and operation of a PDU which will convert one ton of coal per hr into low-Btu gas. All PDU system components and subsystems have been checked out. The integrated solids feed, gasifier/quench, product gas, and combustion air systems were operated successfully at atmospheric pressures for 157 hr, 115 of which were under gasification conditions. Startup was performed with coke fuel. The campaign ended with the gasification of coal at rates up to 400 lb/hr and the production of 100 Btu/scf gas.

11074 (SAN—1429-48) **Molten Salt Coal Gasification Process Development Unit. Quarterly technical progress report No. 12, January-March 1979.** (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). 24 Apr 1979. Contract EF-77-C-03-1429. 23p. Dep. NTIS, PC A02/MF A01.

This represents the 12th quarterly progress report on the Molten Salt Coal Gasification Process Development Unit (PDU) Project. The project includes the design, construction, and operation of a PDU which will convert 1 ton of coal per hour into low-Btu gas. The solids feed, gasifier/quench, product gas, combustion air, ash removal and sulfur removal systems have been operated as an integrated unit. The gasifier was operated at atmospheric pressure for 240 hr, 225 of which were under gasification conditions. Product gas with a heating value of approximately 100 Btu/scf was produced at coal gasification rates up to 440 lb/hr.

11075 (SAN—2069-1-T1) **Support research on chemical, mechanical, and environmental factors in underground coal gasification. Quarterly report.** Edgar, T.F.; Humenick, M.J.; Thompson, T.W.; Gray, K.E. (Texas Univ., Austin (USA). Dept. of Chemical Engineering). 1 Jul 1979. Contract ET-78-S-03-2069. 71p. Dep. NTIS, PC A04/MF A01.

This quarterly progress report covers research work performed at the University of Texas at Austin on evaluating chemical, mechanical and environmental factors in underground gasification of Texas lignite.

11076 **Entrained flow coal gasifier.** Blaskowski, H.J.; Mehta, A.K. (to Combustion Engineering, Inc.). US Patent 4,158,552. 19 Jun 1979. Filed date 29 Aug 1977. 4p.

An entrained flow coal gasifier wherein a high temperature product gas stream is essentially formed by burning char with air. Additional char, formed by partial gasification of coal, is added immediately thereafter to obtain the gasification reaction. Fresh coal is thereafter supplied in a lower temperature region thereby obtaining the volatile components driven off at a relatively low temperature.

11077 **Conversion of coal into hydrocarbons.** Jones, A.R. (to Westinghouse Electric Corp.). US Patent 4,158,637. 19 Jun 1979. Filed date 30 Apr 1976. 14p.

Hydrocarbons are formed from coal and water. The water is converted or dissociated separately into hydrogen and oxygen in a first chemical reactor by the thermochemical and/or electrolytic processing. The resulting hydrogen is then reacted with the coal in a second reactor to produce the hydrocarbons. Residual carbon from the second reactor is reacted in a third reactor with oxygen derived from the first reactor to produce carbon monoxide. The carbon monoxide is reacted with residual hydrogen from the second reactor or hydrogen from the first reactor to produce additional hydrocarbons. The energy for the endothermic and/or electrolytic processing in the reactors and for auxiliary equipment of the apparatus is supplied by a very high-temperature, gas-cooled, nuclear reactor by heat interchange with the cooling gas, helium. The cooling gas operates through heat-exchange means which isolates the cooling gas from the processing apparatus.

11078 **Hydrothermal alkali metal catalyst recovery process.** Eakman, J.M.; Clavenna, L.R. (to Exxon Research & Engineering Co.). US Patent 4,157,246. 5 Jun 1979. Filed date 27 Jan 1978. 12p.

In a coal gasification operation or similar conversion process carried out in the presence of an alkali metal-containing catalyst wherein solid particles containing alkali metal residues are produced, alkali metal constituents are recovered from the particles primarily in the form of water soluble alkali metal formates by treating the particles with a calcium or magnesium-containing compound in the presence of water at a temperature between about 250°F and about 700°F and in the presence of added carbon monoxide. During the treating process the water insoluble alkali metal compounds comprising the insoluble alkali metal residues are converted into water soluble alkali metal formates. The resultant aqueous solution containing water soluble alkali metal formates is then separated from the treated particles and any insoluble materials formed during the treatment process, and recycled to the gasification process where the alkali metal formates serve as at least a portion of the alkali metal constituents which comprise the alkali metal-containing catalyst. This process permits increased recovery of alkali metal constituents, thereby decreasing the overall cost of the gasification process by reducing the amount of makeup alkali metal compounds necessary.

11079 **Two-zone fluid bed combustion or gasification process.** Nack, H.; Liu, K.T. (to Battelle Development Corp.). US Patent 4,154,581. 15 May 1979. Filed date 12 Jan 1978. 10p.

A method of operating a fluidized bed system in a single vessel, typically as a combustor system for power or steam generation burning high-sulfur coal or as a gasifier for high-sulfur coal, which comprises forming an entrained fluidized bed in a first space region containing a first solid bed particle component, such as sand or hematite ore containing over 90% Fe_2O_3, forming in a limited space region partially within the first region a dense fluidized bed containing a second solid bed particle component, such as larger particles of the hematite, both first and second component particles, essentially comprising a material having long-term physical and chemical stability in the fluidized bed system so as to be substantially nonagglomerating and not subject to substantial attrition therein, effecting division of the dense fluidized bed into upper and lower zones, providing a recirculation path such as through a cyclone separator and particle reservoir for the first particle component from the first space region through the upper zone of the dense fluidized bed in the more limited space region, operating the fluidized bed system at a velocity such that the second component particles are effectively retained in the dense fluidized bed in the more limited space region, whereas the first component particles recirculate and interpenetrate through the upper zone thereof commingling with the second component particles, and maintaining different temperatures in the upper and lower zones of the dense fluidized bed. Typically, the temperature of the upper zone of the dense fluidized bed is conducive to capture of sulfur gases by a sorbent while a high temperature in the lower zone of the dense fluidized bed is maintained to be conducive to combustion of fuel and calcination of sorbent (for combustors) or gasification of fuel (for gasifiers).

11080 **Method of solids discharge from coal gasifier grate.** Woodmansee, D.E. (to General Electric Co.). US Patent 4,154,582. 15 May 1979. Filed date 6 Mar 1978. 6p.

A method is described for the discharge of solids from a coal gasifier grate at different radial locations.

11081 **Ninth synthetic pipeline gas symposium.** Contract AP05-790R11826. Arlington, VA; American Gas Association (1977). 654p. (CONF-771092—). American Gas Association, 1515 Wilson Blvd., Arlington, VA 22209 $50.00.

From 9. synthetic pipeline gas symposium; Chicago, IL, USA (31 Oct 1977).

Topics covered include coal gasification pilot plant programs, methanation and combined shift methanation, gasification, biomass and hydrogen, materials engineering for coal gasification, and environmental considerations. Separate abstracts were prepared for 29 papers. Nine papers were previously abstracted.

LIQUEFACTION

REFER ALSO TO CITATION(S) 11033, 11040, 11041, 11053, 11070, 11077, 11187, 11219, 12034

11082 (DOE/ET/00222—2) **Exploratory research on mutagenic activity of coal-related materials. Progress report, August 1-October 31, 1979.** Warshawsky, D.; Schoeny, R.S. (Cincinnati Univ., OH (USA). Coll. of Medicine). 1979. Contract EW-78-S-22-0222. 11p. Dep. NTIS, PC A02/MF A01.

Sample ETTM-13 (coal liquefaction untreated water) was not mutagenic under the condition of testing for strains TA1535, TA1537, TA1538, TA98 or TA100. ETTM-14 (coal liquefaction light oils) was slightly mutagenic for TA1538 and TA98 when tested with Aroclor - induced S-9. Both samples were somewhat toxic for the test organisms, particularly when no S-9 extract was present. Data included on repeat assays of ETTM-10 and ETTM-11 agreed with those previously reported.

11083 (DOE/ET/14876—1) **Catalysts for upgrading coal-derived liquids. Quarterly report, October 1-December 31, 1979.** Crynes, B.L. (Oklahoma State Univ., Stillwater (USA). School of Chemical Engineering). 13 Jan 1980. Contract AC01-79ET14876. 12p. Dep. NTIS, PC A02/MF A01.

The design and partial construction of a new trickle-flow, packed bed reactor system was achieved. This reactor will be used to conduct investigations of throwaway type catalysts and zoned or mixed catalyst beds. It will also be used to support studies of catalyst activity decay. Most of these decay studies will be conducted in the Catalyst Life Test Unit (CLTU). The CLTU has been improved by redesign of the H_2 flow system and several minor changes. A new H_2 supply system has been designed and items ordered for installation. One experimental run was conducted in one of the three reactors of the CLTU. Raw anthracene oil was the feedstock and a vendor catalyst was used (Nalco, NM-502, Ni-Mo-Al_2O_3). Run conditions were: 700F(371C), 1500 psig and 2.0 hour space time (volume hourly). The objective of this run was to test equipment, familiarize personnel and to obtain a data base for future experiments. The sulfur removal was better than 95% throughout the 162 hours of operation. However, nitrogen removal activity decayed from 70% to about 35% after only 30 to 50 hours.

11084 (EPRI-AF—1189) **Coal slurry feed pump for coal liquefaction. Phase II. Final report.** Wong, G.S. (Rockwell International Corp., Canoga Park, CA (USA). Rocketdyne Div.). Sep 1979. 81p. Dep. NTIS, PC A05/MF A01.

Using the materials selection and system concept developed in Phase I, the contractor has completed the detailed design of a slurry feed pump for commercial size coal liquefaction plants. The pumping design requirements were 5000 gpm, 3000 psi, at 550°F. The pump design uses erosion resistant materials in a structurally strong casing. The system concept incorporates features for rapid maintenance and involves multiple modules of identical paired stages. Each pair of stages is set back to back to minimize thrust. The modules are driven by a single motor or turbine with multiple drive shafts. The deliverables by the contractor include a hydraulic design, thermal analysis, and structural analysis plus a complete set of detail drawings. Also included are the manufacturing and test plans for fabrication of the pump. The complete mechanical design of the prototype pump including an assembly drawing with seventy detail drawings, parts lists, and specifications was completed. Because of the proprietary nature of the detailed design, the drawings and manufacturing plan are not included in the final report but are available to authorized invididuals through EPRI.

11085 (FE—0496-160) **Solvent Refined Coal (SRC) process. Quarterly technical progress report, July 1-September 30, 1978.** (Pittsburg and Midway Coal Mining Co., Shawnee Mission, KS (USA)). 1978. Contract EX-76-C-01-0496. 92p. Dep. NTIS, PC A05/MF A01.

This report summarizes the progress of the Solvent Refined Coal (SRC) project by The Pittsburg and Midway Coal Mining Co. for the Department of Energy for the period July 1, 1978 through September 30, 1978. Major activities at the Fort Lewis Pilot Plant included SRC I operation and the test operation of a new type of rotary drum filter, Filter C. A period of SRC II operation using a Pittsburgh seam coal from the Powhatan No. 5 mine was initiated. Merriam Laboratory activities included testing of novel reactors and very short residence times and a study of solvent behavior at SRC II reaction conditions. The Process Development Unit P-99 at Harmarville tested a series of Pittsburgh seam coals in the SRC II process to study both feedstock effects and process variable effects.

11086 (FE—2034-16) **Catalytic hydrogenation for coal-derived liquids. Interim report, June-August, 1979.** Berg, L.; McCandless, F.P. (Montana State Univ., Bozeman (USA)). Sep 1979. Contract EX-76-C-01-2034. 43p. Dep. NTIS, PC A03/MF A01.

The concept of fabricating catalysts specifically designed to hydrodenitrogenate solvent refined coal has been continued. Using catalyst bases of specific surface area, pore volume and pore diameter and impregnating them with tungsten, nickel, cobalt and/or molybdenum has yielded denitrogenation of SRC from 1.17% nitrogen to as low as 0.01% nitrogen after 45 minutes use and 0.1% nitrogen after 90 minutes, and desulfurization of SRC from 0.73% to as low as 0.2% sulfur after three hours. The catalysts appear to be a cross between hydrotreating and hydrocracking catalysts and will require a burn-off and resulfiding after four to six hours of operation. Five additional catalysts have been discovered which appear to offer the possibility of an economically attractive process for converting solvent-refined coal into a feedstock suitable for a conventional petroleum refinery.

11087 (FE—2315-34) **Refining and upgrading of synfuels from coal and oil shales by advanced catalytic processes. Quarterly report, October-December 1978.** Sullivan, R.F. (Chevron Research Co., Richmond, CA (USA)). Jan 1979. Contract EX-76-C-01-2315. 42p. Dep. NTIS, PC A03/MF A01.

Pilot plant tests on the hydrotreating of SRC-II process product indicate that this coal-derived feed is a suitable feed for refining using advanced commercial petroleum processing technology. Experiments are in progress to evaluate several different combinations of refinery processes for conversion of SRC-II to transportation fuels. Nitrogen in the whole SRC-II process product can be reduced to a concentration of less than 0.5 ppM in a single catalytic stage. Sulfur and oxygen can also be reduced to low levels; and at high severity, most of the aromatic compounds are converted to napththenes. The naphtha appears to be an excellent catalytic reformer feed, and the middle distillate meets the smoke point and stability specifications for jet fuel. As the processing severity is decreased, product nitrogen increases; and the product becomes more aromatic.

11088 (FE—2335-T1) **Catalyst development for coal liquefaction. Final report, July 1, 1976-December 31, 1978.** Hindin, S.G. (Engelhard Minerals and Chemicals Corp., Edison, NJ (USA). Engelhard Industries Div.). Jan 1979. Contract EX-76-C-01-2335. 265p. Dep. NTIS, PC A12/MF A01.

The goal of this program is the development of an improved catalyst for coal liquefaction. Catalyst supports, hydrothermally stable at coal liquefaction conditions, were prepared with varying acidities to determine whether this parameter is critical to coal liquefaction and heteroatom removal. Other supports, primarily aluminas, were prepared with widely different pore-size distributions to study the effect of catalyst structure and composition of the support surface. Physical studies of catalysts and supports included measurements of surface area, pore-size distribution and pore-volumes. A technique was developed to measure the acidity of catalysts and supports by programmed desorption of adsorbed bases (ammonia and pyridine). Tests were set up to determine physical stability of catalysts (i.e., abrasion resistance, crush strength and resistance to disintegration in hot oil). An autoclave screening unit was constructed, and a test development program carried out to define the test conditions required for evaluation of catalyst performance. A large number of catalysts were evaluated in the autoclave screening unit. A fixed-bed reactor was designed and commissioned and an operating procedure developed. This type of continuous operation appears to be a practical solution for intermediate catalyst evaluation. Results indicate higher benzene-soluble yields for a large pore preparation and comparable, but more stable performance, than the H-Coal catalyst for a smaller pore, denser catalyst.

11089 (FE—2547-39) **Laboratory program to support H-Coal Pilot Plant operations. PDU Run 7.** (Hydrocarbon Research, Inc., Lawrenceville, NJ (USA)). Aug 1979. Contract EF-77-C-01-2547. 80p. Dep. NTIS, PC A05/MF A01.

PDU Run 7 was designed to create emergency situations under controlled conditions and develop the proper responses to reestablish operations with a minimum of disruption. In addition, the study served to train operating personnel to handle emergencies in the H-Coal Pilot Plant and to start up the new equipment which had been installed since the last PDU operations. The run also generated

process optimization data for operations in the fuel oil mode using Illinois No. 6 coal.

11090 (FE—2566-37) **Upgrading of coal liquids. Monthly technical progress report, December 1979.** Riedl, F.J.; deRosset, A.J. (UOP, Inc., Des Plaines, IL (USA). Corporate Research Center). Jan 1980. Contract EF-77-C-01-2566. 14p. Dep. NTIS, PC A02/MF A01.

Final results for fluid catalytic cracking (FCC) of SRC-II derived gas oils are reported. Results show an increase of conversion with increasing hydrogen content and temperature. Experimental work required under Task 2 of the contract is completed.

11091 (FE—2727-6) **Mass transport characteristics of zeolite cracking catalysts. Quarterly report, January 1-March 31, 1979.** Haynes, H.W. Jr. (Mississippi Univ., University (USA). Dept. of Chemical Engineering). 14 May 1979. Contract EF-77-S-01-2727. 40p. Dep. NTIS, PC A03/MF A01.

An active zeolite hydrocracking catalyst has been prepared by ion exchanging Ni^{++} onto an ammonium ultrastable zeolite Y and then impregnating the resulting catalyst with tungsten. A mixture of hydrogenated phenanthrenes were hydrocracked over this catalyst in a trickle bed reactor over a range of conditions: P = 1500 to 2000 psi, T = 650 to 750°F, SV = 0.5 to 3.0 gm/hr/gm. Operability was generally good for the entire 131 hour run duration. The products will be analyzed by gas chromatography with selected products analyzed by GC/MS. A kinetics model has been developed for the simulated catalytic cracking of various pure hydrocarbons over zeolite NaY. Over the range of concentrations studied, hydrogenation prevails over cracking for partially saturated species like tetralin. The opposite is true for totally saturated naphthenic species such as decalin. However, the kinetic model predicts a higher selectivity toward cracking in a 100% vapor phase (no carrier gas) environment at atmospheric pressure. Tests are underway to check this prediction experimentally. From the magnitude of the activation energies and the relative activities for conversion over NaA and NaY, there does not appear to be any evidence of a pore diffusion limitation for the 3-ring and smaller components studied. (This conclusion may not apply to conventional catalytic cracking processes, however, since the conversion rates over NaY are orders of magnitude smaller than rates over acid forms of the zeolite.) Unexplained discrepancies still exist between theory and experiment in the GC-diffusivity studies on the system n-butane/NaY. Further tests are planned to check the linearity assumptions inherent in the model.

11092 (FE—2893-29) **EDS coal liquefaction process development. Phase IV. Quarterly technical progress report, January 1-March 31, 1979.** (Exxon Research and Engineering Co., Florham Park, NJ (USA)). 1979. Contract EF-77-A-01-2893. 291p. Dep. NTIS (US Sales Only), PC A13/MF A01.

This report is the sixth quarterly technical progress report for US Department of Energy Cooperative Agreement No. EF-77-A-01-2893 for Exxon Donor Solvent (EDS) Coal Liquefaction Process Development - Phase IV. This report covers the period January 1 through March 31, 1979. The Laboratory Process Research and Development studies were conducted at various Exxon Research and Engineering Co. (ER and E) facilities: Research and Development Division at Baytown, Texas, Products Research Division at Linden, New Jersey; and the Exxon Research and Development Laboratories at Baton Rouge, Louisiana. The Engineering Research and Development studies were performed at the Synthetic Fuels Engineering hand Exxon Engineering Technology Departments of ER and E at Florham Park, New Jersey. The information dealing with the Management, Detailed Engineering, and Procurement and Construction of the 250 T/D Exxon Coal Liquefaction Pilot Plant (ECLP) was generated at The Carter Oil Company, Houston, Texas, and Exxon Engineering - Project Management Department of ER and E, Florham Park, New Jersey. Highlights from this report are summarized.

11093 (FE—3055-T4) **SRC-II Demonstration Project. Phase zero, task number 1: deliverable number 3. Demonstration plant supplementary technical studies.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 317p. Dep. NTIS, PC A14/MF A01.

The subjects discussed in this report supplement Deliverable No. 1, Demonstration Plant Description. The intent is to develop in depth some of the problems associated with raw material sources, critical design considerations, prototype equipment, environmental and safety regulations, safety, operability, data base, trade-offs, and confidence analyses. The report includes, where applicable, work that must be done in order to be able to produce the detailed final design for the Demonstration Plant. Areas where final decisions regarding trade-off studies and process configurations have not been made are also indicated.

11094 (FE—3055-T5) **SRC-II Demonstration Project. Phase zero, task number 1: deliverable number 2. Demonstration plant capital and operating cost.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 171p. Dep. NTIS, PC A08/MF A01.

This report contains the various cost estimates prepared by Stearns-Roger for the SRC-II 6700 tpsd Demonstration Plant at Morgantown, West Virginia, with descriptions of the methods used to prepare these estimates and the qualifications for them. The following estimates are included: direct capital costs, elements of indirect capital costs, and elements of annual operating costs. Each of these estimates is presented in November 1978 dollars and in December 1977 dollars. The design revisions described in Section 6 of Deliverable No. 1 Demonstration Plant Description, have been incorporated into all costs. These costs are part of the source information for cash flow projections and relative timing of Budget Authorizations which appear in Deliverable 12, Volumes 1 and 3. Appendix A to this report is a study made by Bechtel Incorporated to provide a third party confirmation of the preliminary capital cost estimate by Stearns-Roger for the design and construction of an SRC-II Demonstration Plant.

11095 (FE—3055-T6) **SRC-II Demonstration Project. Phase zero, task number 2: deliverable number 6. Demonstration plant long lead procurement report.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 18p. Dep. NTIS, PC A02/MF A01.

This work was performed to identify long lead procurement activities required for the design and construction of a 6700 tons per stream day Solvent Refined Coal (SRC-II) Demonstration Plant. The plant design involves the use of both large scale and prototype process equipment which could potentially involve long design and fabrication times that must be ordered early to avoid schedule delay. The long lead items presented in this report were screened from the plant design described in Phase Zero Deliverable No. 1, Demonstration Plant Description. The equipment lists were reviewed to identify long lead equipment both large in scale and prototype. Selection of items was based on review of preliminary specifications and conditions of service with equipment fabricators and suppliers to establish probable delivery times.

11096 (FE—3055-T7) **SRC-II Demonstration Project. Phase zero, task number 1: deliverable number 5. Executive summary.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 19p. Dep. NTIS, PC A02/MF A01.

The SRC-II Demonstration Project is being carried out to demonstrate the economic and technical feasibility of the SRC-II coal liquefaction technology in a full-scale demonstration facility. By demonstrating successfully in a well-designed and operating plant that SRC-II works on a large scale and thereby establishing the cost of producing oil from coal, it should be possible to accelerate the widespread use of this technology to aid in achieving the national energy goals. The SRC-II Demonstration Plant is designed to produce synthetic fuels and by-products. By using these products in engines and boilers, and testing their potential use in refineries and chemical plants, it should be possible during demonstration to establish that coal liquefaction can yield oil that could displace petroleum in most of its major uses. Operation of the Demonstration Plant and the use of its products under controlled conditions will confirm and establish suitable environmental, safety, and health criteria to be applied as commercialization of SRC-II and related technologies occurs. Phase Zero of the Demonstration Project has been carried out to evaluate the current status of the SRC-II Demonstration Plant design and the market and economic prospects for the products of SRC-II. In addition, the initial environmental, geotechnical, and socioeconomic work for the proposed plant site has been undertaken and management plans have been made for the next phase of the Project. Preliminary cost estimates for the Plant and the Project have been produced and The Pittsburg and Midway Coal Mining Co. (P and M) has submitted a plan to DOE to share in the costs.

11097 (FE—3055-T8) **SRC-II Demonstration Project. Phase zero, task number 3: deliverable number 7. First commercial plant description and cost estimates.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 288p. Dep. NTIS, PC A13/MF A01.

The SRC-II process is an advanced coal liquefaction process which is being developed to produce clean, nonpolluting liquid fuel from high sulfur bituminous coals. The goal of this development work is full commercialization. A step in the developmental process is operation of a Demonstration Plant which is described in detail in Demonstration Plant Description, Phase Zero Deliverable No. 1. This volume documents preliminary studies and costs for expanding that Demonstration Plant, which processes 6700 tons per stream day (tpsd) of coal, to a commercial size plant processing 33,500 tpsd. The design and cost estimates of the First Commercial Plant are predicated upon satisfactory operation of the Demonstration Plant wherein: the yield structure is demonstrated for large scale operation; operating problems are economically resolved; and adequate data are obtained or developed concurrently to confirm the scale-up economies used in developing the cost estimate. The philosophy used in

developing the 26,800 tpsd expansion consisted of adding a train or multiple trains where needed in parallel with the Demonstration Plant. The size and number of trains are based on both the SRC-II technology and the equipment fabrication capability anticipated at the time of expansion. This volume describes the First Commercial Plant, presents the product slate, shows estimated utility requirements, and indicates thermal efficiency. Differences from the Demonstration Plant are reviewed, and operability and technical risk are discussed. Capital and operating costs are presented.

11098 (FE—3055-T9) **SRC-II Demonstration Project. Phase zero, task number 1: deliverable number 1. Demonstration plant description.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 1040p. Dep. NTIS, PC A99/MF A01.

This volume presents the conceptual design for a 6700 ton per stream day (tpsd) demonstration-size SRC-II coal liquefaction plant. The plant has been designed as a fully integrated, grass roots facility with the capability of expansion to commercial size. This design approach is consistent with the objectives detailed for Phase Zero in Task 1 of Appendix A of Contract No. DE-AC05-780R03055 (Formerly Contract No. ET-78-C-01-3055) between The Pittsburg and Midway Coal Mining Co. (P and M) and the United States Department of Energy (DOE). Primary engineering and design for the plant was prepared by Stearns-Roger Incorporated under the direction of The Pittsburg and Midway Coal Mining Co. The primary product is a low sulfur distillate fuel oil, suitable for power plant use in areas with stringent sulfur regulations. The physical and chemical characteristics of this coal-derived oil are such that little or no modification is required to burn the product in existing utility boilers. Although the process has been designed to maximize the production of fuel oil, other valuable products are also produced. These additional major process products include: pipeline quality gas, liquefied propane gases, mixed butanes, naphtha, anhydrous ammonia, and sulfur. Special design studies have also been made to assess critical processes and equipment associated with a demonstration or commercial size coal liquefaction plant. These studies include completed reports concerning: reactor kinetics, reactor process dynamics of three-phase flows, gasification designs and systems, hydrogen purification processes and sulfur recovery, oxygen compression, dissolver slurry preheater, and critical equipment, instrumentation, and materials of construction.

11099 (FE—3055-T10) **SRC-II Demonstration Project. Phase zero, task number 1: deliverable number 4. Demonstration plant milestone construction and operation schedules.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 290p. Dep. NTIS, PC A13/MF A01.

The schedules presented herein were developed in accordance with DOE's request to accelerate the Demonstration Plant completion data to December 1983. The qualifications and assumptions for the various schedules and the methodology for development of the schedules are also discussed. The primary assumptions for construction completion by December 1983 are (1) Deliverable No. 1, (Demonstration Plant Description) is the final design basis and does not change substantially during Phase I, (2) data requirements in Deliverable No. 3, Section 8.11, are available in the third and fourth quarters of 1979, and (3) data verification work at Ft. Lewis has been approved and underway. In other words, Phase I will be approved by October 1, 1979, and a confirmed design basis will be completed by the end of calendar year 1979. Confirmation of these schedules were prepared by Bechtel, Inc. and are presented in Appendix A.

11100 (FE—3055-T11) **SRC-II Demonstration Project. Phase zero, task number 7: deliverable number 18. Environmental suitability report.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 82p. Dep. NTIS, PC A05/MF A01.

The Solvent Refined Coal (SRC-II) demonstration plant site proposed by The Pittsburg and Midway Coal Mining Co. (P and M - a wholly owned subsidiary of Gulf Oil Corporation) would be located in the Cass District of Monongalia County, West Virginia, along the West Virginia-Pennsylvania state line. A list identifies relevant environmental laws, rules, and regulations including general explanatory appendices. Compliance with these regulations, with major emphasis on air, water, and solid waste, is discussed with comparison of pertinent data. Proof of compliance, or demonstration of an adequate plan for compliance with these regulations, usually will be required prior to the commencement of construction on the facility, and will result in the issuance of an appropriate permit by the responsible agency. The list is a broad one and includes environmental regulations which may apply only peripherally or not at all to the type of facility P and M proposes to be constructed. Such a broad list is intended to be an aid in safeguarding against oversight, as well as a reference in the event design changes become necessary. In some areas, no regulations have been promulgated specific to coal liquefaction or to the SRC-II process. In this event, regulations or guidelines pertaining to similar facilities have been listed in order to provide a basis for extrapolation. Many of the regulations listed with EPA as the enforcement agency are subject to delegation to the State of West Virginia for enforcement after adequate legislation and enforcement plans have been approved.

11101 (FE—3055-T12) **SRC-II Demonstration Project. Phase zero, task number 3: deliverable number 17. Demonstration plant marketing plan.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 24p. Dep. NTIS, PC A02/MF A01.

The marketing plan for the SRC-II Demonstration Plant recognizes the requirement for market preparedness and product acceptance in the development of commercial coal liquefaction plants. In early 1978, the DOE Deputy Secretary asked the electc utility industry to support the SRC-II demonstration project. A plan was proposed in which the utility industry would purchase and test the demonstration plant fuel oil product for 5 years at a projected long term price. This price would be a premium over the normal cost of utility fuel in order to subsidize DOE's effort to develop a domestic source of fuel oil made from coal. In this way, user industries and producer industries would be involved in the Demonstration Project. Currently more than twenty electric utilities have indicated their willingness to support the SRC-II demonstration program in this manner. A similar arrangement has been proposed for the pipeline gas product and a major gas utility company has indicated willingness to participate. The marketing plan includes provisions for testing applications and upgrading steps of other light hydrocarbons, non-hydrocarbon by-products, and certain liquid fractions.

11102 (FE—3055-T13) **SRC-II Demonstration Project. Phase zero, task number 1: deliverable number 16. Site suitability report.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 364p. Dep. NTIS, PC A16/MF A01.

The site proposed for the SRC-II Demonstration Plant is located in Cass District Monongalia County, West Virginia about seven miles north of Morgantown. The site borders the Monongahela River and the Pennsylvania State line. There is a total of 2430 acres purchased, leased, or under option. The site generally consists of gently rolling hills atop a plateau about 300 feet in elevation above the river. A railroad runs through the site along the river. The site is located within a high sulfur coal mining area and within fifty miles of mines expected to supply coal to the Demonstration Plant. A rail transportation network already in place would be used to transport coal to the plant. The railroad is capable of handling the increased traffic. Water for the Demonstration Plant will be taken from the adjoining Monongahela River. Power will be supplied by Monongahela Power Company, part of Allegheny Power Systems, Inc. They will provide service from two separate sources to improve reliability of the electrical supply system. There is a municipal water system in the area which could supply potable water during construction of the plant. Transportation facilities near the proposed plant site are generally good. A railroad runs through the site, a navigable river borders the property, and an interstate highway is about five miles distant. The site is about 65 miles from the Pittsburgh International Airport which provides extensive air service.

11103 (FE—3055-T14) **SRC-II Demonstration Project. Phase zero, task number 7: deliverable number 14. Environmental analysis status report.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 504p. Dep. NTIS, PC A22/MF A01.

The Phase Zero portion of the Environmental Analysis consists of subtasks for seasonal and non-seasonal data collection and reporting, EIS (Environmental Impact Statement) liaison, and environmental suitability analysis and reporting. This is the Environmental Analysis Status Report which presents data collected in the first two subtasks; EIS liaison activities are reported in the subtask entitled Environmental Suitability. Studies contained herein were undertaken to perform the baseline work necessary to evaluate the environmental impact of a proposed coal conversion facility using the Solvent Refined Coal (SRC-II) process. The site, located in the Cass District of Monongalia County, West Virginia, was selected for detailed study from among several sites considered during early planning. Data presented encompass three sampling periods which represent about 70 percent of the baseline program. Site specific baseline studies and literature searches began in July 1978. Final field sampling for the planned 12 month program is scheduled for the summer of 1979. Stearns-Roger scientific staff has performed baseline field work with the exception of subcontract work awarded for daily operation of the meteorology and air quality system, infiltration and geotechnical studies, socioeconomic studies, and the archaeology and historical survey. Various laboratory analyses were performed on air, water, sediments, soils, and aquatic organisms using standard and approved laboratory methods.

11104 (FE—3055-T15) **SRC-II Demonstration Project. Task control plans, phase zero.** (Pittsburgh and Midway Coal Mining Co.,

Denver, CO (USA)). 12 Dec 1978. Contract ET-78-C-01-3055. 38p. Dep. NTIS, PC A03/MF A01.

The Task Control Plans developed by P and M and Stearns-Roger serve as useful tools for the control of project manpower, costs and schedules during Phase Zero. The control plans supplement the Project Management Plan and are a further exemplification of the management control systems and a procedures presented in the SRC-II Demonstration Project Management Plan. Budgeted manpower is tabulated on each Task Control Plan below a diagram showing milestone and intermediate event schedules by task and subtask. Actual manpower by task also will be tabulated for comparison with the budgeted manpower and significant variances will be explained. Close supervision of manpower variances is a prime factor for cost control since it is recognized that costs during Phase Zero essentially are controlled by manpower. The Task Control Plans will be used to monitor the progress of each task and subtask and for determination of the monthly status of each activity within a task. An estimate of percentage completion for each task will be tabulated on the Task Control Plans on a monthly basis.

11105 (FE—3055-T16) **SRC-II Demonstration Project. Project management plan, phase zero.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 8 Dec 1978. Contract ET-78-C-01-3055. 69p. Dep. NTIS, PC A04/MF A01.

The SRC-II Demonstration Project will result in the design, construction, operation and evaluation of a coal liquefaction plant from which the primary product is an environmentally acceptable liquid fuel oil derived from domestic high-sulfur bituminous coal. The project is comprised of four phases. Phase Zero consists of a preliminary design for a 6000 TPCD Demonstration Plant module, cost estimates for this module and an expansion to a full 30,000 TPCD Commercial Plant plus conceptual design and cost estimates for a 30,000 TPCD grass roots plant, development of an organization to direct and manage the project, and various other plans and reports. Among these are a cost sharing plan, a plan for project completion, a market analysis and an economic evaluation of the SRC-II design. This phase began on July 10, 1978, and will be completed on April 30, 1979. Phase I, II, and III are described briefly.

11106 (JPL-PUBL—78-56, pp 258-261) **Status report of the SRC-I and SRC-II processes.** Chenoweth, G.E. (Gulf Mineral Resources Co., Denver, CO). 15 Aug 1978.

From Conference on coal use for California; Pasadena, CA, USA (9 May 1978).

After sixteen years of bench-scale and pilot plant development, large solvent refined coal (SRC) demonstration plants are being planned which could lead to commercialization by the late 1980's.

11107 (JPL-PUBL—78-56, pp 262-267) **H-coal process: a status report.** Voss, W.C. (Ashland Oil, Inc., KY). 15 Aug 1978.

From Conference on coal use for California; Pasadena, CA, USA (9 May 1978).

H-coal is a catalytic process involving the direct hydrogenation of coal to produce hydrocarbon liquids. Its development was started in 1963 by Hydrocarbon Research, Inc., a subsidiary of Dynalectron. The process has operated at the bench scale level on a wide variety of coals including eastern US, western subbituminous and lignites from Texas and North Dakota as well as foreign coals. A three-ton per day process development unit has also been operated extensively, confirming bench scale results and adding substantially to the technical data base. The process affords wide flexibility of operation from fuel oil to syncrude modes. A pilot plant now under construction at Catlettsburg, Kentucky is scheduled for completion March 31, 1979. It will be the largest coal liquefaction plant on-line in the US, processing up to 600 tpd of coal. Concurrent with the pilot plant, other development activities are being undertaken to provide timely initiation of a commercial project. Assuming successful operation of the pilot plant in 1979, engineering on a 50,000 BPD plant is scheduled to start in early 1980, construction in mid-1981 and operations beginning in late 1984.

11108 (JPL-PUBL—78-56, pp 268-272) **Exxon donor solvent coal liquefaction process.** Epperly, W.R.; Swabb, L.E. Jr., Taumton, J.W. (Exxon Research and Engineering Co., Florham Park, NJ). 15 Aug 1978.

From Conference on coal use for California; Pasadena, CA, USA (9 May 1978).

Exxon Research and Engineering is developing a donor solvent coal liquefaction process to produce low-sulfur liquid products from a wide range of coals. The primary goal is to achieve a state of commercial readiness by 1982 through an integrated program of laboratory and engineering research and development in conjunction with operation of a 250 T/D pilot plant. The basis for this development project and the status of the program are discussed.

11109 Liquefaction of calcium-containing subbituminous coals and coals of lower rank. Brunson, R.J. (to Exxon Research & Engineering Co.). US Patent 4,161,440. 17 Jul 1979. Filed date 21 Nov 1977. 6p.

An improved process is disclosed for the treatment of a calcium-containing subbituminous coal and coals of lower rank to form insoluble, thermally stable calcium salts which remain within the solids portions of the residue on liquefaction of the coal, thereby suppressing the formation of scale, made up largely of calcium carbonate which normally forms within the coal liquefaction reactor (i.e., coal liquefaction zone), e.g., on reactor surfaces, lines, auxiliary equipment and the like. An oxide of sulfur, in liquid phase, is contacted with a coal feed sufficient to impregnate the pores of the coal. The impregnated coal, in particulate form, can thereafter be liquefied in a coal liquefaction reactor (reaction zone) at coal liquefaction conditions without significant formation of scale.

11110 Method of filtering molten coal. Mueller, H. (to Chemap AG). US Patent 4,157,305. 5 Jun 1979. Priority date 20 Jun 1975, Switzerland, 8p.

A process for filtering molten coal is provided. The process comprises the steps of providing a filter, passing a stream of molten coal which includes some solid material against said filter and filtering the solid material so as to form a filter cake on and to pass a filtrate through said filter, directing a stream of inert gas against said filter cake so as to dry the same to a predetermined low moisture content, centrifuging said dried filter cake off said filter, separating from the filter cake a fraction composed of fine particles, adding said separated fine particles to a stream of molten coal upstream of said filter, and passing said stream of molten coal and separated fine particles against said filter, whereby said fine particles act as a filter aid for the filtration of the molten coal. The process can also comprise adding calcium oxide or an inorganic salt to a stream of molten coal whereby the added compound acts as a filter aid, and subsequently recovering the added compound and again adding it to a stream of another coal.

11111 Process for extending life of coal liquefaction catalyst. Paraskos, J.A.; Taylor, H. Jr. (to Gulf Research and Development Co.). US Patent 4,157,291. 5 Jun 1979. Filed date 15 Feb 1978. 12p.

A catalytic process for liquefying coal is described wherein the life of the catalyst is extended by periodic screening to remmove ash-containing particulate matter.

11112 Process for extending life of coal liquefaction catalyst. Paraskos, J.A.; Taylor, H. Jr. (to Gulf Research & Development Co.). US Patent 4,157,291. 5 Jun 1979. Filed date 15 Feb 1978. 12p.

A catalytic process for liquefying coal is described in which the life of the catalyst is extended by periodic screening to remove ash-containing particulate matter.

11113 Use of deashed coal as a flushing agent in a coal deashing process. Leonard, R.E.; Rhodes, D.E. (to Kerr-McGee Corp.). US Patent 4,153,538. 8 May 1979. Filed date 20 Mar 1978. 8p.

A process for maintaining the fluid-like properties of a heavy phase being withdrawn from a separation zone maintained at elevated temperature and pressure during periods in which the flow of this heavy phase is terminated due to pressure reduction valve plugging or to permit cleaning of downstream processing apparatus. When the flow of withdrawn heavy phase is interrupted, deashed coal is melted, if necessary, and introduced under pressure into the withdrawal conduit to mix with the heavy phase therein. The mixture of deashed coal and heavy phase retains the fluid-like properties exhibited by the heavy phase and flow can be resumed once the downstream apparatus is repaired. Alternatively, other high-boiling aromatic materials may be used instead of the deashed coal.

11114 Manufacture of hydrocarbon oils by hydrocracking of coal. Raichle, L.; Kroenig, W. US Patent 4,152,244. 1 May 1979. Priority date 2 Dec 1976, German, Federal Republic of (F.R. Germany), 8p.

Production of hydrocarbon oils by hydrocracking of finely ground coal under pressure by slurrying the coal, optionally with a catalyst, in a mixture of middle and heavy oil produced by the process, and heating the slurry to 380° to 440°C together with hydrogen under 100 to 400 bars pressure, and then passing the mixture through one or more reaction chambers kept at 420° to 490°C. The reaction products are passed to one or more hot separators, part of the gas and vapor thus separated being passed through one or more reaction chambers containing a fixed hydrogenation catalyst. The other part of the separated gas and vapor is cooled directly. The middle and heavy oil used for the slurry is in part middle and heavy oil derived from the directly cooled steam while the other portion is a distillate oil derived from the bottoms sludge of the hot separator.

11115 Coal liquefaction process. Yan, T.Y.; Espenscheid, W.F. (to Mobil Oil Corp.). US Patent 4,151,066. 24 Apr 1979. Filed date 12 Jan 1978. 14p.

This invention provides an improved method for solubilizing carbonaceous material which comprises contacting and dissolving comminuted coal in a highly aromatic petroleum residum solvent

having a special chemical constituency and physical properties, and thereafter separating the solution phase from the undissolved solids.

11116 Liquid fuels from Canadian coals. Taylor, G.W. Ottawa, Ontario; Minister of Supply and Services Canada (1979). 52p. (CANMET—79-13). Canmet Publication Office, 555 Booth St., Ottawa, Ontario.

In Canadian energy planning, the central issue of security of supply must be addressed by developing flexible energy systems that make the best possible use of available resources. For liquid fuel production, oil sands and heavy oil currently appear more attractive than coal or biomass as alternatives to conventional crude oil, but the magnitude of their economic advantage is uncertain. The existence of large resources of oil sands, heavy oils, natural gas and low-sulfur coals in Western Canada creates a unique opportunity for Canadians to optimize the yield from these resources and develop new technology. Many variations on the three basic liquefaction routes - hydroliquefaction, pyrolysis and synthesis - are under investigation around the world, and the technology is advancing rapidly. Each process has merit under certain circumstances. Surface-mineable subbituminous and lignite coals of Alberta and Saskatchewan appear to offer the best combination of favorable properties, deposit size and mining cost, but other deposits in Alberta, Nova Scotia and British Columbia should not be ruled out. The research effort in Canada is small by world standards, but it is unlikely that technology could be imported that is ideally suited to Canadian conditions. Importing technology is undesirable: innovation or process modification to suit Canadian coals and markets is preferred; coprocessing of coal liquids with bitumen or heavy oils would be a uniquely Canadian, exportable technology. The cost of synthetic crude from coal in Canada is uncertain, estimates ranging from $113 to $220/m^3 ($18 to $35/bbl). Existing economic evaluations vary widely depending on assumptions, and can be misleading. Product quality is an important consideration.

BY-PRODUCTS

REFER ALSO TO CITATION(S) 11035

PROPERTIES

REFER ALSO TO CITATION(S) 11053, 11056, 11093, 12235

11117 (EPRI-FP—1228) **Moessbauer effect spectroscopic study of pyritic sulfur in coal. Final report.** Levinson, L.M. (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). Oct 1979. 66p. Dep. NTIS, PC A04/MF A01.

The Moessbauer spectroscopic technique has been adapted to provide a reliable measurement of pyritic sulfur in coal. The Moessbauer method is quick, nondestructive, and adaptable to automation. It can be applied to processed as well as raw coals. Several difficulties hindering the use of Moessbauer spectroscopy for pyritic measurements have been resolved. Sample homogenization techniques consistent with the spectroscopic requirements were developed. A special sample holder compatible with a 5 to 10 g coal sample was designed. Two calibration curves were evaluated: one based on a mixture of pyrite and graphite, the other on HCl-leached coal. A simple correction method for the effects of ash absorption was demonstrated. Nine coals from different seams were evaluated; two of these coals had been cleaned by advanced coal cleaning methods. Differences between the Moessbauer and ASTM wet chemical methods for analyzing pyritic sulfur in coal were evaluated. Good agreement was shown, provided residual undissolved pyrite in the ASTM method is taken into account. Analysis of spectrometer capability indicates a routine sample could be analyzed in about 10 minutes. Spectrometer cost is estimated at $15,000.

11118 (ORNL—5629) **ORNL coal chemistry report, 1979. Executive summary.** Grimes, W.R.; Guerin, M.R.; Keller, O.L.; Poutsma, M.L.; Watson, J.S. (Oak Ridge National Lab., TN (USA)). Feb 1980. Contract W-7405-ENG-26. 269p. Dep. NTIS, PC A12/MF A01.

The ORNL Coal Chemistry Report for 1979 outlines the existing and needed chemical bases for current and future coal utilization in direct combustion, liquefaction, and gasification and also for chemical feedstocks. We include recommendations for chemical developments needed to underpin production of energy, fuels, and chemical products from coal and also recommendations related to environmental and health effects. Various methods of chemical analysis of coal materials are described with detection limits, and applicability to particular elements. (LTN)

11119 (DOE-tr—201) **Use of nuclear magnetic resonance for analyzing high-molecular fractions of fuel samples.** Lang, I.; Sebor, G.; Kosina, M.; Kustka. M. Translated from *Sb. Pr. UVP :* **35**: 190-238(1978). 30p. Dep. NTIS, PC A03/MF A01.

Methods used for calculating structural parameters of high-molecular portions of fuel samples based on the data of ^1H and ^{13}C NMR are summarized. A potential application of the above in our fuel analytical technique is discussed.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 11053, 11057, 11080, 11130, 11844, 11845, 11852, 12460, 12469, 12470, 12471

11120 (IMMR—40-RRR5-78) **Fourth Kentucky coal refuse disposal and utilization seminar.** Rose, R.G. (ed.). (Kentucky Univ., Lexington (USA). Inst. for Mining and Minerals Research). Dec 1978. 89p. (CONF-7806170—). Univ. of Kentucky, Lexington, KY.

From 4. Kentucky coal refuse disposal and utilization seminar; Pineville, KY, USA (6 Jun 1978).

This document contains the proceedings of the Fourth Kentucky Coal Refuse Disposal and Utilization Seminar held at Pine Mountain State Resort Park near Pineville, Kentucky, June 6-7, 1978. Ten papers have been entered individually into EDB and ERA. (LTN)

11121 (IMMR—40-RRR5-78, pp 41-47) **Coal refuse utilization in road construction.** DiMillio, A.F.; Besselievre, W.C. (Federal Highway Administration, Washington, DC). Dec 1978.

From 4. Kentucky coal refuse disposal and utilization seminar; Pineville, KY, USA (6 Jun 1978).

This paper discusses the current efforts of the FHWA Offices of Research and Development in determining the proper utilization of coal refuse in road construction. The Office of Development is preparing a Users Manual for Coal Refuse in Highway Embankments, and the Office of Research is investigating the use of coal refuse/fly ash compositions as a pavement base course material. Both of these contract studies are in the early stages of performance; however, details of current progress and future plans are highlighted. In the United States, 3.5 billion tons of coal refuse are stored in unsightly and environmentally damaging coal-refuse piles. At the present time, over 100 million tons of additional coal refuse are being generated annually in the United States to add to the waste problem. These figures are expected to go even higher now that coal has emerged as a top priority fuel source for our country.

11122 (IMMR—40-RRR5-78, pp 51-54) **New trends in fine refuse vacuum filtration.** Klepper, R.P. (Envirotech Corp., Salt Lake City, UT). Dec 1978.

From 4. Kentucky coal refuse disposal and utilization seminar; Pineville, KY, USA (6 Jun 1978).

Vacuum filtration has been used for many years as a means to dewater fine refuse. Current expansion of coal preparation with more emphasis on recovering 28 x 0 mesh coal and governmental action regulating refuse disposal has made fine refuse dewatering a more important part of the preparation plant flowsheet. This paper discusses the parameters that directly and indirectly effect the operation of fine refuse vacuum filtration, and also several new evolutionary designs and operational innovations that can increase the efficiency of fine refuse dewatering.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 11100, 11103, 11120, 11138, 11199, 11367, 12444, 12468, 12515, 12516, 12526, 12647, 12657

11123 (ANL/EES-TM—72) **Assessment of the local air quality impacts of increased coal use resulting from implementation of the National Energy Plan.** Kellermeyer, D.A.; Levine, E.P. (Argonne National Lab., IL (USA)). Aug 1979. Contract W-31-109-ENG-38. 65p. Dep. NTIS, PC A04/MF A01.

The National Energy Plan (NEP) contains a number of national energy goals that may come into conflict with national air quality goals as stated in the Clean Air Act Amendments of 1977 (CAAA). This report provides a preliminary assessment of air quality impacts resulting from the increased coal consumption aspects of the NEP. Specifically, the implications of changes in local concentrations of sulfur doxide (SO_2), total suspended particulates (TSP), and nitrogen dioxide (NO_2) were analyzed for the years 1985 and 1990. Counties containing or projected to contain post-1975 coal use by either utilities or major industries were examined to determine if the amount of coal use projected would lead to violation of prevention of significant deterioration (PSD) regulations or National Ambient Air Quality Standards (NAAQS). The report findings are summarized for both the national and regional levels.

11124 (ANL/EES-TM—74) **Water quality impacts of increased coal utilization.** Chiu, S.Y.; Torpy, M.F.; Gasper, J.; Habegger, L.J.; Hoover, L.J. (Argonne National Lab., IL (USA)). Apr 1979. Contract W-31-109-ENG-38. 101p. Dep. NTIS, PC A06/MF A01.

The potential cumulative water quality impacts of expanded future coal use in the United States was investigated under the National Energy Plan (NEP). The NEP calls for nearly doubling of coal production and use over the next ten years. A surface water quality model was developed to estimate regional water quality impacts. The quantity of pollutants expected to be discharged as a result of coal extraction, coal-fired steam electric power generation, and industrial coal use was characterized in detail for individual sources with specific control requirements that take into account regional differences. From the pollutant loadings, the model calculates the incremental impacts based on dilution capacity of streams. It is concluded that, although water quality impacts from industrial coal use are expected to be greatly reduced due to the enactment of recent environmental laws, intense development of coal mining and coal-burning facilities may cause water quality problems in a few areas, notably the Upper Ohio River Basin, the Northern Great Plains, and the Upper Colorado River Basin. Judicious siting of coal mines and coal-burning facilities is needed to avoid adverse water quality impacts in areas where stream assimilative capacity is limited. Improved mine-sealing techniques for reducing acid mine drainage from underground mines in the East are also required. Additional critical water quality issues demanding close attention are: (1) leaching and migration of trace elements contained in uncombusted coal residuals; (2) acidification of water resources resulting from increased emissions and deposition of sulfur dioxide and nitrogen oxide; and (3) local and regional water quality problems resulting from reduced surface water dilution capacity due to increased water consumption.

11125 (FES—79-21(Pt.1)) **Final environmental statement. Development of coal resources in southern Utah. Part 1. Regional analysis.** Menard, H.W. (Geological Survey, Denver, CO (USA)). 1979. 225p. Geological Survey, Land Information and Analysis Office, Denver, CO.

The proposed actions are based on three formally proposed mining and reclamation plans to produce coal from eight mines on Federal lands in southern Utah. Impacts are evaluated for the years 1980, 1985, and 1990 for population-related effects and for the life of the project for site-related effects. The statement also considers the cumulative impact of the Allen-Warner Valley (A-WV) Energy System, a 2,500 megawatt electric power generation project. The A-WV project, exclusive of the Alton mine, is being considered in a site specific EIS being prepared by BLM. The statement is in two parts; the first part (Regional Analysis) evaluates the cumulative impacts of four scenarios of development and the second part (Site-specific analyses) specifically evaluates each proposed action. Land surface on 18,584 acres would be disturbed; the Alton mine would affect 8,280 acres and the A-WV project 9,588 acres over the entire project life. After reclamation, land use probably would change permanently on 1,725 acres. Total water use would be 43,940 acre-feet per year consisting of 42,040 acre-feet per year for the A-WV project, 240 acre-feet per year for mining and 1,660 acre-feet per year for public supply. The A-WV project may impact a threatened or endangered species (woundfin) and disturb rare species (Gila monster, desert tortoise, desert bighorn sheep). The economy and tax revenues of a sparsely settled area would be sharply expanded. A dozen other items are discussed briefly.

11126 (FES—79-21(Pt.2)) **Final environmental statement. Development of coal resources in southern Utah. Part 2. Site specific analysis.** Menard, H.W. (Geological Survey, Denver, CO (USA)). 1979. 206p. Geological Survey, Land Informaton and Analysis Office, Denver, CO.

The El Paso Coal Company has submitted plans for approval to mine 6.8 million tons of coal per year (mty) from two underground mines. This environmental analysis details the impacts that would result from approval of these mining plans. The company has also submitted preliminary plans for transportation, utilities, and other facilities that will be needed to support the mining operations. The components of the mining plans now awaiting Federal action and the preliminary proposals requiring Federal action at some later date are described. El Paso Coal Company lease holdings are on the Kaiparowits Plateau about 30 miles north of Page, Arizona, and about 28 miles south of Escalante, Utah. Nine coal seams have been identified in the lease area (40,546 acres) by exploration drilling. Of these nine seams, only six will be mined from the Red mine and two from the Blue mine. The Red mine would produce 200 million tons over a projected 38-year mine life and the Blue mine 6 million over a 12-year projected mine life. Coal recovery would be 50 percent of estimated inplace reserves. Excess coal thickness and minimum seam separation preclude greater recovery under present technology.

11127 (IMMR—40-RRR5-78, pp 1-3) **Office of Surface Mining abandoned lands reclamation program.** Maneval, D.R. (Office of Surface Mining, Washington, DC). Dec 1978.

From 4. Kentucky coal refuse disposal and utilization seminar; Pineville, KY, USA (6 Jun 1978).

The Office of Surface Mining program consists of two major program efforts - enforcement of surface mining regulations for the active mining industry and a major abandoned lands reclamation program. This paper discusses the roles of the State and Federal governments in administering this abandoned lands program.

11128 (IMMR—40-RRR5-78, pp 5-15) **Revegetation research on surface-mined land in eastern Kentucky.** Vogel, W.G. (Forest Service, Berea, KY). Dec 1978.

From 4. Kentucky coal refuse disposal and utilization seminar; Pineville, KY, USA (6 Jun 1978).

Revegetating surface-mined lands in eastern Kentucky received little attention before 1958. Thereafter, revegetation efforts based mostly on experience and standard reforestation practices were only occasionally successful. Research started by the US Forest Service in 1958 and expanded in 1962 helped to define some of the revegetation problems and suggest how to overcome them. Important research was conducted on the suitability of woody and herbaceous species; effects of spoil properties on plants; requirements for fertilizer, lime, mulch, and seedbed preparation; feasibility of all-season seeding; compatibility of trees with herbaceous cover; and microbial associations. Recent research by other Federal and state agencies is also briefly discussed.

11129 (IMMR—40-RRR5-78, pp 17-19) **Effects of surface mining on hydrology, erosion, and sedimentation in eastern Kentucky.** Curtis, W.R. (Forest Service, Berea, KY). Dec 1978.

From 4. Kentucky coal refuse disposal and utilization seminar; Pineville, KY, USA (6 Jun 1978).

Research by the US Forest Service Unit at Berea, Kentucky, has shown that surface mining results in increases in storm peak flows during and immediately after mining, but that peaks may be significantly lower after reclamation is completed. Impoundments on surface-mine lands can be effective in controlling runoff and erosion provided the ponds are properly constructed. Erosion and subsequent sedimentation are greatest during early stages of mining but diminsh rapidly as the land is reclaimed and vegetation growth progresses.

11130 (ISM—250) **Environmental significance of power plant fly ash.** Chang, C.Y.; Murtha, M.J.; Burnet, G. (Ames Lab., IA (USA)). 1979. Contract W-7405-ENG-82. 12p. (CONF-791069—4). Dep. NTIS, PC A02/MF A01.

From 6. annual conference on energy; Rolla, MO, USA (16 Oct 1979).

Potential environmental impacts of fly ash associated with its leachates and radioactivity are discussed. The amounts of heavy metals in fly ash leachates and of radiation from naturally occurring radionuclides in fly ashes are capable of causing pollution problems. The Ames Laboratory has developed two processes, the Ames Lime-Soda Sinter process and the Ames HiChlor process, to extract metals from fly ash. Recoveries are very promising, thus indicating the possibility of converting the ash into useful products while reducing the waste disposal problem.

11131 (PB—290918) **Coal mine water pollution legal and regulatory issues: a survey.** Final report. Fisher, A.B. (Illinois Inst. of Natural Resources, Chicago (USA)). Oct 1978. 49p. NTIS, PC A03/MF A01.

The Illinois Mine Related Pollution Task Force is a joint activity of the Illinois Coal Association and the Illinois Environmental Protection Agency. The Task Force's activities are coordinated by the Illinois Institute of Natural Resources. The Task Force decided that the achievement of their goal would be furthered by surveying rules and regulations governing mine related water pollution in other bituminous coal producing states. The basic problem which the Task Force is addressing in the survey is the extent to which other major bituminous coal producing states are experiencing differences between their effluent standards and their water quality standards and what, if anything, is being done to resolve differences where they occur. The states selected for study in this report are Colorado, Indiana, Kentucky, Ohio, Pennsylvania, West Virginia and Wyoming.

11132 (PB—293457) **Groundwater quality monitoring of western coal strip mining: identification and priority ranking of potential pollution sources.** Everett, L.G. (General Electric Co., Santa Barbara, CA (USA). Center for Advanced Studies). Jan 1979. Contract EPA-68-03-2449. 265p. NTIS PC A12/MF A01.

This report is the first in a series of several to come out of a 5-year study to assess the impact on groundwater quality of coal strip mining in the Western United States. Presented is a preliminary priority ranking of potential sources of groundwater pollution in an area within Campbell County, Wyoming, overlying one of the major coal fields in the Powder River Basin. The priority ranking was developed by making a thorough review of the existing data available from monitoring activities of mining companies and various

county, State, and Federal agencies. Potential pollution sources and methods of waste disposal at seven operating mines and also in the vicinity of the City of Gillette were inventoried. The data were carefully reviewed to identify the potential pollutants associated with each source. Groundwater usage was inventoried. An appraisal of the hydrogeologic framework and existing groundwater quality was developed. By superimposing the identified potential groundwater pollution sources on the hydrogeologic framework and making estimates of pollutant mobilities from these sources, the preliminary priority ranking was developed.

11133 (PB—298191) **Coal and the environment abstract series. Bibliography on mined-land reclamation. Final report.** Gleason, V.E. (Bituminous Coal Research, Inc., Monroeville, PA (USA)). Apr 1979. 383p. NTIS, PC A17/MF A01.

This volume is the third to appear in the 'Coal and the Environment Abstract Series' and is a new edition of 'Reclamation of Coal Mined-Land: A Bibliography with Abstracts.' The other volumes in the series are 'Mine Drainage Bibliography 1910-1976' and ' A Bibliography on Disposal of Refuse from Coal Mines and Coal Cleaning Plants.' The three Bibliographies in the 'Coal and Environment Abstract Series' are intended to complement one another. While each covers one particular subject area, inevitably some documents listed in one also are relevant to one of the other Bibliographies. In addition to the abstracts, this volume includes an Author Index and a General Index.

RESERVES AND EXPLORATION

11134 (CONF-781108—, pp 193-208) **Geostatistical methods in lignite reserve estimation.** Tolley, H.D.; Alldredge, J.R. (Texas A and M Univ., College Station). Jul 1979.

From 4. DOE statistical symposium; Albuquerque, NM, USA (1 Nov 1978).

This paper applies and illustrates the use of methods of determining spatial variability as used in ecology and mineral exploration to estimate lignite reserves from common drill hole data. The current techniques of exploring lignite reserves have remained basically unchanged since about 1930 and consist of analyzing data gathered using expensive grid type drilling strategies. During the past 20 years, statistical methodology in mineral ore reserve estimation, however, has developed to include several correlation modeling techniques. The methodology uses results from applied stochastic processes and resembles some of the methods used in estimating spatial variability in forestry studies. In this paper these techniques are adapted to analyze coal-lignite deposit data. The results suggest methods of improving drilling strategies and estimates of reserves in exploratory geology.

11135 (FE—8972-1) **Analytical bases for electromagnetic sensing of coal properties.** Wait, J.R.; Chang, D.C.; Lytle, R.J.; Ralston, M.A.; Umashankar, K.R.; Wittmann, R.C. (Cooperative Inst. for Research in Environmental Science, Boulder, CO (USA); Colorado Univ., Boulder (USA); National Oceanic and Atmospheric Administration, Boulder, CO (USA)). Jul 1978. Contract ET-75-G-01-8972. 356p. Dep. NTIS, PC A16/MF A01.

A number of theoretical problems have been studied that are relevant to the electromagnetic probing of the environment in coal mines. Particular emphasis was given to methods of determining the roof structures in underground workings. Essentially the idea is that the structure is illuminated by a source of primary field and the secondary response is detected. This secondary field is then related to the roof structure. The following approaches were employed: (i) low frequency induction wherein the induced eddy-currents give rise to a secondary measurable field, (ii) direct current excited by probes that interact with the inhomogeneous roof structure, (iii) microwave coupling to the roof by resonant loops, (iv) microwave reflection and scattering by horn antennas. The collected results presented here are intended to provide an analytical framework for further work in this area.

11136 (JPL-PUBL—78-56, pp 140-141) **Coal use in California: viewpoint from Utah.** Searle, R. 15 Aug 1978.

From Conference on coal use for California; Pasadena, CA, USA (9 May 1978).

Unless regulatory roadblocks can somehow be removed, and water projects funded, California cannot count on receiving any more electricity from the State of Utah other than what it will receive from the Intermountain Power Project. In summary, lack of federal coal leasing programs or coal leasing exchange programs, the Endangered Species Act, BLM wilderness review, problems in developing a short water supply, all impede substantially Utah's ability to develop its own resources and in particular its ability to share those resources with other states. Utah won't take an isolationist position if it can meet its own requirements. We find ourselves, however, with regard to water and coal and power plant development, in what we call a federal straightjacket. We have found in Utah that industry has been quite willing to work with us to meet the demands of the State and the requirements of the State. In fact, in some instances, they have gone beyond what has been required of them. We expect that industry, utility industries especially, will do a good job in protecting the environment and financing without being required to, financing the infrastructure and taking care of the impacts they cause. Finally Utah, as indicated before, will not build additional power plants for California if such plants can be built within the State of California and meet the same regulations. Nor will Utah slurry coal to California unless the policy of water exchange is implemented.

11137 (USGS-OFR—79-2-ER) **Evaluation of the mineable coal reserves of the northern Bevier, Mendota, and Novinger Coal Fields in north-central Missouri.** Robertson, C.E.; Smith, D.C. (Missouri Dept. of Natural Resources, Rolla (USA). Div. of Geology and Land Survey). 1979. Contract ET-76-G-01-9080. 104p. Dep. NTIS, PC A06/MF A01.

Remaining demonstrated resources and reserves were computed for the northern half of the Bevier, and the Mendota and Novinger Coal Fields by thickness, depth of overburden, and degree of reliability. A total coal resource base of 1020.2 million short tons was computed as of November 30, 1977 in portions of Randolph, Chariton, Macon, Adair, and Putnam Counties. As of November 30, 1977, the northern Bevier Field contained a remaining demonstrated coal resource base of 314.9 million short tons, the Mendota Field 246.2 million short tons, and the Novinger Field 459.1 million short tons. Demonstrated recoverable reserves were computed at 612.4 million short tons for portions of the five county area. The northern Bevier Field contains a remaining demonstrated recoverable reserve of 217.3 million short tons, the Mendota Field 154.6 million short tons, and the Novinger Field 240.5 million short tons. Demonstrated recoverable reserves of strip coal were calculated as follows: northern Bevier Field, 192.4 million short tons; Mendota Field, 114.4 million short tons; and Novinger Field, 66.4 million short tons. The combined total for all 3 fields is 373.2 million short tons. Obstructions to mining are present within the three coal fields and are described: areas of nondeposition, faults, channelization or erosion, etc.

MINING

REFER ALSO TO CITATION(S) 11035, 11125, 11126, 11132, 11133, 11135, 11367, 12285

11138 (ANL/AA—11) **National Coal Utilization Assessment. An integrated assessment of increased coal use in the Midwest: impacts and constraints.** (Argonne National Lab., Evanston, IL (USA)). Oct 1977. Contract W-31-109-ENG-38. 541p. Dep. NTIS, PC A23/MF A01.

This study examines the impacts and constraints to increased coal production and use for a 14-state Midwestern region. The assessment considers technology characteristics, energy supply and demand trends, siting constraints, impacts on water availability and coal reserves, impacts on air and water quality, and ecosystems, effects of trace elements, social and economic impacts, and health risks. The significant air quality constraints to coal use are related to the short-term National Ambient Air Quality Standards, PSD standards, and exposure to sulfates. In general, cumulative water supply in the 14-state region is adequate to satisfy foreseeable energy requirements; however, on a localized basis significant water shortages may develop which could constrain a smaller portion of the energy development. Water quality impacts are primarily restricted to areas with insufficient water resources. Coal mining will continue to have significant effects on water quality in smaller streams draining the major coal regions unless strict control practices are maintained. Coal-conversion plants may cause localized water quality problems; however, the effluent characteristics of these plants are not well-known. A significant amount of the coal development is anticipated to occur in counties with high susceptibility to social and economic impacts. The timing, magnitude, and nature of these impacts could be mitigated by the development of effective management strategies.

11139 (DOE/EIA—0118(76)) **Coal: bituminous and lignite in 18 Dec 1978.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 18 Dec 1978. 69p. Dep. NTIS, PC A04/MF A01.

Bituminous coal and lignite production in 1976 reached an alltons high of 678.7 million tons, a 4.7% increase over the 648.4 million tons produced in 1975. The increase occurred primarily as a result of the increased demand for coal by electric utilities. The total valuation of production in 1976 was $13.2 billion compared with $12.5 billion in 1975. In 1976, there were 6161 bituminous coal and lignite mines which operated in 26 states. Prices of coal increased only moderately in 1976. The average mine price of bituminous coal and lignite increased from $19.23 per ton in 1975 to $19.43 per ton in

1976. Employment increased from 189,880 men in 1975 to 202,280 men in 1976. The decline in productivity was less in 1976 than in 1975. Productivity at underground mines declined from 9.54 tons per man per day to 9.10 tons per man per day. Productivity at surface mines declined from 26.69 tons per man per day to 26.40 tons per man per day. The average productivity at all mines declined from 14.74 tons per man per day in 1975 to 14.46 tons per man per day in 1976. In 1976, the United States exported 59.4 million tons, a decrease of 6.3 million tons compared with exports in 1975.

11140 (DOE/ET/10023—T1) **Development of optimal terrace pit coal mining systems. Technical progress report, October 1- October 31, 1979.** (Kaiser Engineers, Oakland, CA (USA)). 19 Nov 1979. Contract AC01-79ET10023. 36p. Dep. NTIS, PC A03/MF A01.

A bibliography on various aspects of optimal terrace pit coal mining systems is included. Relevant federal and state legislation and regulations have been identified. Mines of interest to the project have been identified and listed for field visits. Seven regions of different climates, hydrology, geology, etc., are being studied individually. (LTN)

11141 (DOE/RA—0045) **Western coal development monitoring system.** (Department of Energy, Washington, DC (USA). Div. of Coal Production Technology). Jan 1980. 38p. Dep. NTIS, PC A03/MF A01.

The Western Coal Development Monitoring System (WCDMS) is a periodic survey of all known operators of existing and planned large (200,000 tons or more annual production) coal mines in the Western United States. The purpose of the survey is to track progress and changes in productive capacity. Specifically, the survey seeks estimates of current and future productive capacity, of amounts of coal currently under contract, and of potential constraints to higher production. The survey is conducted periodically by telephone. Questions are asked about potential productive capacity; coal under contract; key Federal and State permits missing; other legal, contractual or legislative barriers; transportation; and the need for leasing of Federally owned coal.

11142 (FE—1231-15) **Design optimization in underground coal systems. Sections 1-4. Interim report, October-December 1978.** Haycocks, C. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Dept. of Mining and Minerals Engineering). Mar 1979. Contract EX-76-C-01-1231. 68p. Dep. NTIS, PC A04/MF A01.

Work on the structural properties of coal and rocks was confined to preparation of the final report Structural Characteristics of Coal. Continued effort was made to upgrade and improve the longwall simulation. As part of the effort, a fresh look is being taken at the method of calculating support loads and in particular the method of determining whether a roof will form a cantilever behind the chock line. The system, based purely on strata strength, density, modulus, and thickness consideration, appears limited in scope as it ignores the rock mass properties. Therefore, a rock mass classification method of characterizing the roof strata is being investigated. In particular this would allow evaluation of the joint systems in addition to other structural properties and should provide a more realistic determination of support load. The major problem with the approach is seen to be the difficulty in obtaining adequate rock mass data from exploration boreholes. This problem is also to be investigated particularly in the light of new down-the-hole geothermal investigation devices. Work continued on the final report of the roof truss portion of the work. The report includes the theory, modeling method, experimental and field data, and the analysis and correlation of the above, in addition to recommendations concerning efficient installation and usage of roof trusses.

11143 (FE—3271-T1) **Consolidation of bad top at the Virginia Pocahontas Division of Island Creek Coal Company.** von Schonfeldt, H.; Pothini, R. (Occidental Research Corp., Irvine, CA (USA)). 1 Mar 1979. Contract ET-78-C-01-3271. 87p. Dep. NTIS, PC A05/MF A01.

A test was conducted to stabilize broken roof rock (bad top) in the Beatrice Mine of the Beatrice Pocahontas Company. The technique was originally developed in Europe and is based on injecting polyurethane into the friable roof strata through a predetermined number of drill holes. Upon curing, the polyurethane recements the rock fragments into place and forms a consolidated mine roof. The tests were carried out in the headgate entry of a longwall system. The objective of this work was to demonstrate that polyurethane could be successfully used to prevent roof falls in an area that would otherwise be difficult to support and thereby provide a cost effective means of maintaining an essentially uninterrupted longwall operation. A total of 10.7 tons of polyurethane was forced into the rock through 60 boreholes drilled into the roof. The test was completed approximately 3 months before the mining front passed through the consolidated area. Continued monitoring of the roof in the test area indicated that the roof had been sufficiently stabilized and that no significant roof falls were eminent. When the mining front moved through the test area, no slowdown of the longwall productivity was experienced. The longwall productivity in the 200 foot long test area actually increased approximately 35% over the average productivity prior to reaching the test area. The demonstration test therefore was regarded successful in preventing a major roof fall in a highly unstable area and in maintaining average or better longwall mining productivity. It was found that chemical consolidation is particularly well suited for applications around longwall systems because the method has the potential of maintaining high longwall production even under difficult ground conditions.

11144 (FE—8917-2) **Steam engine analysis. Final technical report.** Allbach, W.G.; Smith, M.J.; Wenshutonis, R.F. (Barnes and Reinecke, Inc., Elk Grove Village, IL (USA)). Jun 1979. Contract ET-77-C-01-8917. 140p. Dep. NTIS, PC A07/MF A01.

The objectives of this contract were the familiarization, cost analysis, and thermodynamic analysis of a prototype Rankine cycle steam engine. This steam engine is intended for application in an underground vehicle. The cost analysis was made, by direction, for the material and direct labor based on a single prototype steam engine extended to lots of 100 units and 500 units annually. Support data for this cost analysis are contained herein. The conclusions derived from the familiarization and the cost analysis are that the cost is higher than alternate vehicle power systems, (i.e., batteries, diesel, cable reel, etc.), the design and configuration is not in a state of reproducibility and maintainability, and needs to be reconfigured for cost reduction. The thermodynamic analysis of the effect of the steam power plant upon the mine environment was based on previously reported data and the characteristics of this single prototype steam engine (PSE) operating in a laboratory environment on a fixed dynamometer. The analysis indicates that the steady state temperature in the mine entry air downstream of the steam powered vehicle would increase significantly while the steam engine is operating, unless the ventilation air flowrate is increased above the minimum 9000 CFM requirement.

11145 (FE—9040-1(App.1)) **Technical assessment of patents related to underground coal mine haulage. Appendix I. Power driven conveyors.** Singh, M.M.; Jaspal, J.S.; Presti, R.L.; Hair, R.T.; Yates, G.A. (Engineers International, Inc., Downers Grove, IL (USA)). 17 Nov 1978. Contract ET-76-C-01-9040. 546p. Dep. NTIS, PC A23/MF A01.

More than two hundred patents related to power driven conveyors are evaluated. (LTN)

11146 (METC/SP—79/9) **Proceedings of the second annual methane recovery from coal beds symposium.** Wise, R.L. (ed.). (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center). Apr 1979. 243p. Dep. NTIS, PC A11/MF A01.

Topics covered include methane recovery from coal seams by vertical drilling and by long horizontal drill holes in the seam. Preliminary degassing of the deeper seams may be necessary for safety and productivity in mining them. The recovery of the methane represents the conservation of a resource now largely wasted by venting in mine ventilation air and, in some cases, the economics are favorable. Resource assessment is being carried out and drilling equipment designed for coal seam degassing is described. Seventeen papers from the proceedings have been entered individually into EDB and ERA. (LTN)

11147 (METC/SP—79/9, pp 9-16) **Status report: Methane Recovery from Coalbeds Project.** Wise, R.L. (Morgantown Energy Tech. Center, WV). Apr 1979.

In Proceedings of the second annual methane recovery from coal beds symposium.

In 1977, the Morgantown Energy Technology Center added to its Unconventional Gas Recovery activities, the Methane Recovery from Coalbeds Project. Based on US Bureau of Mines data, the project was directed at the recovery and utilization of methane associated with active mining operations and the resource verification of the gas potential associated with unmined coalbeds. A summary of project progress and current status is presented.

11148 (METC/SP—79/9, pp 17-22) **Commercialization of coalbed methane.** York, T.B. (Dept. of Energy, Washington, DC). Apr 1979.

In Proceedings of the second annual methane recovery from coal beds symposium.

A series of energy technologies with near-term potential have been studied by the Department of Energy to determine barriers to their immediate commercialization and to consider the range of Federal actions that could potentially overcome the barriers. Where R & D is complete, responsibility for marketing is transferred to an appropriate Assistant Secretary for commercialization. Unconventional gas recovery, including coalbed methane, is to be commercialized under the Assistant Secretary for Resource Applications. Part of the strategy of the Commercialization Plan for Recovery of Natural Gas from Unconventional Sources is to make development of coalbed methane more attractive to the local use market. Of particular significance is a proposed project to demonstrate the

technical and economic feasibility of local gas utilities to produce and distribute natural gas from coalbeds. The commercialization of coalbed methane is in its infancy. The Department of Energy is pursuing a plan aimed at reducing barriers to commercialization of this resource. A significant activity that will contribute to the plan is the APGA project to demonstrate the technical commercial feasibility of utilizing gas from coalbeds and Devonian shale for purpose of community and rural development.

11149 (METC/SP—79/9, pp 23-26) **US Bureau of Mines Program for methane drainage to reduce safety hazards in coal mines.** Deul, M. (Bureau of Mines, Pittsburgh, PA). Apr 1979.

In Proceedings of the second annual methane recovery from coal beds symposium.

The US Bureau of Mines Program for degassing coalbeds involves drilling long holes in the coal seam to let the methane out. This program will be more important with newer, deeper mines (which are gasier) and where ventilation is more expensive. A rough rule of thumb is that if the coal bed contains 5 to 6 cc of methane per gram, problems of safety in mining can be anticipated. To take care of the problems by ventilation requires costly shafts and high air velocity. Methane drainage before mining should reduce these problems. (LTN)

11150 (METC/SP—79/9, pp 27-44) **Controlling production mechanism of methane gas from coalbeds.** Kuuskraa, V.A.; Hammershaimb, E.; Doscher, T.M. (Lewin and Associates, Inc., Washington, DC). Apr 1979.

In Proceedings of the second annual methane recovery from coal beds symposium.

Methane occluded in coal seams constitutes a large resource of natural gas which has remained essentially untapped. In the last few years, interest in this resource has increased, but the physical parameters and technical aspects governing its recovery are still not well understood. This paper investigates the production characteristics of methane from coal and describes a framework for evaluating the physical mechanisms controlling the production of this resource. An understanding of the controlling production mechanism is necessary when considering which recovery method to use. This choice may well depend on whether recovery is limited by fracture permeability or by the amount of gas that can diffuse from the coal face into fractures. This paper provides a framework for evaluating recovery under two production mechanisms and over a wide range of physical parameters, such as the diffusion coefficient and coal seam permeability. After reviewing the basic theory, an analysis is presented of the controlling production mechanism for the Pittsburgh and Pocahontas coals. Analysis has shown that methane recovery from coal seams can be either diffusion- or permeability-limited, depending on the physical parameters of the coalbed. At the lower end of the range reported for diffusion constants, recovery is limited by diffusion, and increasing production will require connecting large additional surface areas to the wellbore.At the upper range of the reported diffusion constant, recovery is permeability-limited. Increased recovery might then be obtainable by increasing the wellbore radius or the permeability.

11151 (METC/SP—79/9, pp 45-55) **Vagarious nature of methane gas from coalbeds.** Stefanko, R. (Pennsylvania State Univ., University Park). Apr 1979.

In Proceedings of the second annual methane recovery from coal beds symposium.

This paper is a progress report on three vertical wells drilled into the Pittsburgh Coal Seam in Greene County (southwestern Pennsylvania) on US Steel's Cumberland Mine Property. The results from these wells are compared with others in the general area to show the erratic results one can obtain. There appears to be no way of predicting the results a priori with any degree of accuracy nor can satisfactory explantations be given of the different performances noted. A discussion of possible explanations of the varying nature of methane flow from beds is given. The methane flow was not sufficient from any of these vertical wells to amortize the cost of drilling and well development. Since the energy crisis continues and promises to get worse, we must turn to our most plentiful energy source - coal. There are two primary sources: the shallow, strippable coals which abound in the west and the very deep coal seams in the east and midwest. For the latter, some method of degasification will be essential if they are to be mined. Recognizing this, coal companies are planning on the use of the in-mine, horizontal-hole seam degasification technique. For the Cumberland site, no additional vertical holes are being planned. However, since severe gas problems are being encountered underground, a horizontal drill has been ordered and horizontal, long hole degasification will take place in the mine.Furthermore, Consolidation Coal does not plan on the further use of vertical boreholes but also plans to use the horizontal hole technique. In fact, they have spent a lot of time and effort to develop a suitable guidance system to keep the drill hole positioned in seams that undulate. It is anticipated that many such degasification projects will be started in active mines in the near future.

11152 (METC/SP—79/9, pp 56-65) **Review of utilization of methane gas from coalbeds in the United Kingdom.** Hole, W.L. (National Coal Board, London, England); Morris, I.H. Apr 1979.

In Proceedings of the second annual methane recovery from coal beds symposium.

The paper has shown how geological, geographical and market forces have shaped the nature and direction of coalbed methane utilization in the UK. The depth of coal measures and predominance of longwall mining techniques have led exclusively to the extraction of gob gas at around 45 to 50% methane content by the technique of continuous methane collection progressing with the mining of coal from longwall faces. Safety and mining requirements and a high degree of mechanization have led to the extracted gas at the mine surface being available at zero attributed value. Coal output and the nature of the strata determine extraction rates. These rates are generally between 100 and 600 billion Btu's per year and rarely exceed one trillion Btu's from a single mine. At the lower rates on-site use is the only option, whilst above 200 to 300 billion Btu's sales to local industry within a radius of about two miles are currently attractive. At the one trillion Btu level it is economic in the UK to transmit the gas over a distance of ten miles. Combination of outputs from several mines into a pipeline serving a multiplicity of customers is becoming more common and has many practical advantages. Increased utilization of coalbed methane in the UK will be accomplished by the on-site use of gas down to 30% methane content, by blending outputs from mines and possibly by the development of industry adjacent to coalbed methane sources.Markets for the gas are diverse and well established with sales to local industry giving an attractive payback on capital investment. The technology of practical mine drainage and gas utilization have been well proven in the UK and can be offered worldwide through Coal Processing Consultants, a subsidiary of the National Coal Board.

11153 (METC/SP—79/9, pp 66-81) **Degasification parameters and well completion procedures for the Mary Lee/Blue Creek Coalbeds in Tuscaloosa County, Alabama.** Ancell, K.L. (INTERCOMP Resource Development and Engineering, Inc., Houston, TX); Stevenson, J.W. Apr 1979.

In Proceedings of the second annual methane recovery from coal beds symposium.

The Mary Lee/Blue Creek coals have properties that make degasification by wells attractive. In order to achieve effective degasification, a multiple well pattern is necessary. Further, each well must be capable of lifting large volumes of water. A high volume airlift can be used to lift large volumes of water in a hostile environment producing some solids. This high volume airlift can be converted to a closed rotative gaslift system when wells begin to produce sufficient quantities of gas. A pattern of wells can be planned such that the mining plan can be utilized to enhance the interference created by individual wells. The wells can be planned for multiple use as gob drainage holes after mining.

11154 (METC/SP—79/9, pp 82-95) **Extraction, collection, and utilization of coalbed methane.** Sturgill, C.L. (Westinghouse Electric Corp., Pittsburgh, PA). Apr 1979.

In Proceedings of the second annual methane recovery from coal beds symposium.

Internal Westinghouse evaluations of on-site development and use of coalbed methane have shown that power generation is generally more attractive economically than pipeline injection. This tentative conclusion is, however, very sensitive to actual site conditions. One of these conditions, for example, in pre-mining methane recovery, is the rate of flow which can be achieved. In marginal areas where flow rates are reduced, sufficient fuel may not be available for power generation. At the same time, these same flows may be quite acceptable (economically) for pipeline injection provided the pipeline is not too far away and right-of-way costs are not prohibitive. This type of situation exists at the Westmoreland County site discussed earlier, where the reservoir characteristics are extremely poor for a power generation application, but still useful for local recovery, transportation (short distances) by pipeline, and local conversion to industrial process heat. In the case of power generation applications associated with coal mining activities, Westinghouse has focused on turbine-generator configurations of the Saturn and Centaur class. These systems are manufactured by SOLAR Turbines International, and are rated at 800 kW and 2500 kW, respectively. They appear to be the largest practical size for application in which the overall system is developed around the coal mining degasification program.

11155 (METC/SP—79/9, pp 96-113) **Degasification of the Blue Creek coal seam at Oak Grove mine.** Stubbs, P.B. (US Steel Corp., Monroeville, PA); Dobscha, F.X.; Mahoney, J.V. Apr 1979.

In Proceedings of the second annual methane recovery from coal beds symposium.

During 8 months operation of 17 vertical degasification boreholes at Oak Grove, more than 140 million cubic feet of gas was removed. Some holes were excellent producers while others were less than satisfactory. Flow-back of proppant sand and resulting pump malfunctions have been recurring major problems. Results are

encouraging enough to expend further efforts toward improving production from these holes. To do this, the pumps will have to be lowered to the coal seam and more efficient methods found to dewater the coal seam. Future stimulation treatments will be designed to reduce the amount of propping sand used so as to decrease the flow-back of proppant into the borehole.

11156 (METC/SP—79/9, pp 114-130) **Methane production from Snodgrass No. 2, Pricetown, West Virginia.** Shoemaker, H.B.; Rennick, G.E.; Wise, R.L.; Gilmore, D.W. (Morgantown Energy Tech. Center, WV). Apr 1979.

In Proceedings of the second annual methane recovery from coal beds symposium.

The Snodgrass No. 2 well is completed within the Pittsburgh coal seam near the Pricetown I Underground Coal Gasification (UCG) Project at Pricetown, West Virginia. The well was originally drilled as a deep gas well, but was later plugged back and completed within Pittsburgh coalbed (860 feet deep). Attempts at gas production indicated there may have been severe wellbore damage and pressure tests indicate that the coal seam is of a tight, low permeability matrix, approximately 0.01 md. Desorption data from coal cores at Pricetown I indicate that the methane content of the Pittsburgh coal at Pricetown is 50 to 100 cf/ton. A small water frac treatment was designed and conducted on the coal seam (3700 gal water and 1500 lb sand). The permeability of the coal seam was improved to 5.2 md; however, injection tests indicated only short fracture lengths (estimated fracture length of 12 ft). Following the pressure injection tests a pump was placed in the well and the water pumped off. The gas production rate stabilized at approximately 400 cfd methane and the water production at 1 bpd. based on the production data obtained, a model was used to predict the well's performance if a large stimulation or multiple well program were implemented. From these data it appears that vertical wells in the Pittsburgh coal seam at the Pricetown site are not likely to produce commercial gas in the near future.Even if the coal were given a large volume stimulation, creating a 750-foot hydraulic fracture, the resultant initial flows of around 400 cfd would still not be considered commercially recoverable quantities of gas. The behavior of the Pittsburgh coal in this area is considered anomalous as the pressure and gas contents are very low considering the depth and character of the coal.

11157 (METC/SP—79/9, pp 131-146) **Methane recovery from deep mines.** Von Schonfeldt, H. (Occidental Research Corp., Lexington, KY). Apr 1979.

In Proceedings of the second annual methane recovery from coal beds symposium.

A number of preliminary tests were conducted in a deep mine in southwest Virginia to determine whether advance methane control through long horizontal holes is feasible. All data generated in this study indicate that the potential for effective methane drainage is good. The expected flow from the horizontal boreholes is large enough as to warrant the installation of an underground piping system. Such a piping system offers the opportunity to recover the gas for a useful purpose. Additional work is required to determine optimum hole spacing for effective degasification is a given time period. Directional control of the horizontal holes and reliability of the drilling hardware are expected to remain the major problem areas in the near term. The concept of advance methane drainage through horizontal holes in the coal seam rather than through vertical holes from the surface is currently seen as the most cost effective method for the deep southwest Virginia coal mines. The characteristics governing the flow of methane in the Pocahontas # 3 coal seam vary with location on a relatively small scale. This implies that a study similar to the present one might be required for each mine before committing major capital expenditures to a specific methane drainage program. In order to determine the effect of the degasification program on mining productivity more work is required. Some information will become available shortly when the entries around holes 3, 4, and 5 will be developed.

11158 (METC/SP—79/9, pp 147-161) **Hydraulic stimulation of the Pittsburgh coal seam: a case study.** Mazza, R.L. (CONOCO, Morgantown, WV). Apr 1979.

In Proceedings of the second annual methane recovery from coal beds symposium.

A vertical well was drilled through and completed in the Pittsburgh coal seam to evaluate gas inflow reductions into nearby development mining and to compare predicted and actual fracture behaviors in the Pittsburgh coal seam of northern Marion County, WV. The short-term project indicated that two closely spaced wells provided significant reductions of gas inflows into the mine. A hydraulically created fracture was mined through and visual inspections indicated that fracture length and width differed from predicted values by an order of magnitude. Fracture penetration of three strata overlying the seam was observed.

11159 (METC/SP—79/9, pp 162-176) **Directional drilling for coalbed degasification in advance of mining.** Diamond, W.P.; Oyler, D.C. (Bureau of Mines, Pittsburgh, PA). Apr 1979.

In Proceedings of the second annual methane recovery from coal beds symposium.

The US Bureau of Mines has conducted research in directional drilling for degasification in advance of mining since 1973. This technique is designed to combine the highly successful underground horizontal degasification drilling technology with surface drilling methods. The use of directional drilling techniques will be particularly useful in areas where access to gassy coalbeds is not possible underground, and where topography makes multiple sites for vertical degasification holes impractical or prohibitively expensive. Previous research in this program has been conducted by the Bureau of Mines at sites near Jollytown and Mather, PA. Near Waynesburgh, PA, the Emerald Mine directional hole is designed to start from the vertical and enter the Pittsburgh coalbed horizontally at a vertical depth of approximately 1000 feet. The drilling program includes a 3-inch diameter pilot hole to be drilled to the coalbed with a downhole motor and later reamed to 8 3/4 inches for 5-1/2-inch OD casing. Three individual 3-inch diameter 3000-foot horizontal gas collection holes will be drilled into the coalbed in a bird foot pattern. Previous experience has shown the need for determining the thickness and coalbed elevation at the anticipated coalbed intercept, and the general attitude of the coalbed in the area to be drilled. It has also been determined that dewatering of the coalbed, which is essential for degasification, cannot be effectively accomplished using currently available pumping equipment operated in a horizontal position. To obtain the required specific geological data, a corehole has been drilled at the anticipated coalbed intercept. A vertical hole has been drilled at the same location for dewatering the coalbed. Seven vertical holes for monitoring the progress and effectiveness of coalbed degasification have been drilled within the horizontal drilling area.

11160 (METC/SP—79/9, pp 177-184) **Methane drainage turbodrills.** Maurer, W.C. (Maurer Engineering Inc., Houston, TX); Wise, R.L. Apr 1979.

In Proceedings of the second annual methane recovery from coal beds symposium.

Maurer Engineering has developed high power turbodrills specifically designed for drilling methane drainage boreholes. These turbodrills utilize high torque blades which deliver 2 to 3 times more power than the turbine blades used in competitive motors. These improved blades allow the motors to be much shorter and more powerful than competitive motors. Large roller thrust bearings allow the application of the high bit weights needed for fast drilling. Because of the higher power output and the high capacity bearings, these turbodrills drill 3 to 4 times faster than conventional rotary drills, resulting in significantly reduced drilling costs. Both 5-3/8 inch and 7-3/4 inch turbodrills are currently being marketed. A new 3/1/4 inch turbodrill specifically designed for drilling horizontal methane drainage boreholes in coal seams is currently being developed and will be commercially available soon.

11161 (METC/SP—79/9, pp 194-214) **Evaluation of the methane content and resources of Colorado coals.** Murray, D.K.; Tremain, C.M. (Colorado Geological Survey, Denver). Apr 1979.

In Proceedings of the second annual methane recovery from coal beds symposium.

Since 1975, the Colorado Geological Survey has been conducting an evaluation of the content and potential resources of methane in Colorado coal beds. Compilation of available data revealed that gassy conditions, explosions, and fires, costing hundreds of lives, have occurred in more than 130 coal mines throughout the State from the 1880's to the present. The gassy coal mines of record are located primarily in the southern part of the Raton Mesa coal region, Las Animas County, and in the southeastern part of the Uinta region, Gunnison and Pitkin Counties. These mines are in structural basins of Laramide age that exhibit moderate to intense tectonic deformation. These areas contain the gassiest currently producing coal mines in Colorado, which, in total, vent (i.e., waste) over 11 million cu ft (0.3 million m^3) of methane per day. Previous cooperative studies with the Bureau of Mines (and our current study sponsored by the Colorado Oil and Gas Conservation Commission) stressed minable coal beds, whereas our present efforts with the DOE emphasize unmined/unminable coal. Since early 1976, the Colorado Geological Survey, using standard desorption methods, has measured the gas content of more than 120 fresh coal samples cored by evaluation drilling programs conducted by both the US Geological Survey and industry at approximately 20 sites in four of the State's eight coal-bearing regions. Total gas content of these cores ranged from almost zero to 492 cu ft/ton (15.4 cc/g); and depths sampled varied from 100 to 4709 ft. Selected samples of the desorbed coal gas have been analyzed and found to have methane contents of from 46 to 99% and heating values of from 465 to 997 Btu/cu ft.

11162 (METC/SP—79/9, pp 215-216) **Delineation of methane resources in unminable and minable coalbeds.** Lee, A.A. (TRW Energy Systems Group, McLean, VA). Apr 1979.

In Proceedings of the second annual methane recovery from coal beds symposium.

As a major part of its activities as the Integrating Contractor for the Methane Recovery from Coalbeds Project, TRW is assisting the DOE in its delineation of the methane resource. Delineation of the methane content of the nation's coalbeds has been done on a very limited basis, mostly in conjunction with active mining. Previous work includes only a very small percentage of the coal resource and does not provide the knowledge needed to locate recovery and utilization projects in coalbeds with the greatest potential for methane production. The objectives of the MRCP resource delineation effort are threefold: to estimate more reliably the amount of methane in coalbeds of the United States; to determine the producibility of the resource; and to determine the characteristics which allow exploration data and production technologies to be extrapolated from test sites to larger resource areas. To accomplish these objectives, a resource delineation plan was developed which defines an approach to providing a data base for determining the national resource and the reserve, and guiding management of the overall effort. The plan encompasses examination of 380,000 square miles of coal bearing rocks in the conterminous United States, to determine the quantity, distribution and production characteristics of some 789 trillion cubic feet of methane estimated to be contained in those rocks.

11163 (PB—293256) **Laboratory evaluation of the MRDE scrubber. Report of investigations.** Divers, E.F.; Janosik, J.J.; Payton, L.E. (Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Mining and Safety Research Center). 1979. 17p. NTIS, PC A02/MF A01.

The Bureau of Mines report describes the results of a laboratory evaluation of a mechanical dust collector (scrubber) suitable for underground coal mine applications. The scrubber was developed by the Mining Research and Development Establishment (MRDE), Burton-On-Trent, England, and tested at the Federal Bureau of Mines Pittsburgh Mining and Safety Research Center (PMSRC) as part of a technical exchange program. The 2,000-to 8,000-cfm scrubber consists of an electrically driven vane-axial fan, water sprays, a 2-inch-thick, loosely knit stainless steel wire filter panel, and a water droplet eliminator. The dust-laden airstream travels axially through the water sprays, filter panel, fan, and eliminator. Slurry water drains into a sump where a belt-driven pump recycles it back to the sprays. Fractional breakdown tests showed a maximum dust collection efficiency of 96 pct of respirable-size (less than 7 micrometers) coal dust at 2,000 cfm. Efficiency decreased with increasing airflow; for example, to 91% at 6,000 cfm. Following these tests the original wire panel was replaced with a similar but smaller panel developed at PMSRC; a marked improvement in dust collection occurred at all flow rates tested.

11164 (PB—293285) **Coal recovery from underground bituminous coal mines in the United States, by mining method. Information circular 1978.** Reese, R.G.; Dash, B.B.; Hamilton, P.A. (Bureau of Mines, Pittsburgh, PA (USA). Eastern Field Operation Center). 1978. 37p. NTIS, PC A03/MF A01.

During fiscal year 1977 the Bureau of Mines conducted a study to estimate current recoveries obtained by different types of mechanized mining systems in underground coal mines. The study also attempted to define the effects on recovery of different coalbed and mine characteristics. For this study, a number of deep mines were chosen from each major bituminous coal-producing State, and a procedure was developed for estimating the recovery obtained by each mining system used in these mines. This report gives a detailed account of this methodology and presents groupings of these estimates of recovery based on readibly obtainable mine and coalbed characteristics such as mining method used, annual production, market served, and coalbed thickness. Using a statistical test and these groupings, relationships were developed from which conclusions could be drawn. Other factors that may adversely affect recovery were identified by mine personnel but were not examined because of project constraints. A distribution showing the citation frequency of these factors is also included in this report.

11165 (PB—294186) **Development of an improved tamper-proof filter cassette. Open file report (final).** Fafaul, G.F. (Bendix Corp., Baltimore, MD (USA). Environmental and Process Instruments Div.). 7 Aug 1978. Contract H0252094. 19p. NTIS, PC A02/MF A01.

This investigation was concerned with the design, development, fabrication, and testing of an improved tamper-proof filter cassette assembly for use in the collection and evaluation of dust particles, primarily in mining areas. This report presents the design effort, fabrication and testing of five prototype units, and the design and production of 1,000 filter cassettes with sampling heads. This new improved filter cassette has been tested and approved as meeting the specified requirements.

11166 (PB—294627) **Application of a total system surface mine simulator to coal stripping. volume I. executive summary. Open file report (final) 30 June 1975-15 November 1977.** Ramani, R.V.; Manula, C.B. (Pennsylvania State Univ., University Park (USA). Dept. of Mineral Engineering). 1 Feb 1978. 37p. NTIS, PC A03/MF A01.

This report, volume I of a seven-volume report, provides an executive summary of the purpose and scope, objectives, and results of the research. The remaining volumes of the report, describe in detail model development, input and output documentation, and three case studies. Under the project an open pit materials handling simulator was modified and extended for application to surface coal mining. In addition, two equipment selection models, and a cost model were also developed.

11167 (PB—294628) **Application of a total system surface mine simulator to coal stripping. volume II. user's manual for a surface mining materials handling simulator. Open file report (final) 30 June 1975-30 June 1976.** Manula, C.B.; Albert, E.K.; Ramani, R.V. (Pennsylvania State Univ., University Park (USA). Dept. of Mineral Engineering). 30 Sep 1976. 464p. NTIS, PC A20/MF A01.

This report is mainly concerned with the modification and development of a users manual for an open pit materials handling simulator developed at Pennsylvania State University for the Bureau of Mines. Model modifications included the introduction of a free-format input, the application of a Weibull random generator, facilities to stochastically simulate shovel-dragline operations, and routines to increase the flexibility in making truck assignments. At the same time, core storage requirements and execution times were minimized and all of the university's conventions were removed to allow operation on other computing systems.

11168 (PB—294629) **Application of a total system mine simulator to coal stripping. volume III. equipment selection models. Open file report (final) 30 June 1975-29 June 1976.** Ramani, R.V.; Iroegbu, M.; Manula, C.B. (Pennsylvania State Univ., University Park (USA). Dept. of Mineral Engineering). 30 Sep 1976. 216p. NTIS, PC A10/MF A01.

In this report, the application and limitation of the various equipment available for surface coal mining are discussed. The correction factors for adjusting equipment performance arising from machine design, material characteristics, and modes of operation are presented. Engineering design, pit layout, and equipment selection are discussed with mathematical derivations. Two computer programs have been written to aid in pit design and equipment selection. One program can be used to select the bucket size and reach of shovels and draglines for various pit widths. It will also calculate the number of drills, loading shovels, trucks, and bulldozers needed to achieve a production target. The second program can be used to select the number of bulldozers, scrapers, and front-end loaders needed to achieve the desired production.

11169 (PB—294630) **Application of a total system surface mine simulator to coal stripping. volume IV. surface coal mine cost model. Open file report (final) 30 June 1975-1 September 1977.** Ramani, R.V.; Murray, C.W.; Manula, C.B. (Pennsylvania State Univ., University Park (USA). Dept. of Mineral Engineering). 15 Sep 1977. 270p. NTIS, PC A12/MF A01.

This report presents a computer model to perform cost analysis on a wide range of surface coal mining operations. The model generates a selling price for coal based on a combination of many engineering and economic variables. While the model is free-standing, the input data for the model can be generated from the geologic and engineering information using the computer models presented in volumes II and III of this report. The model can be executed with limited data using the default values where information is scarce.

11170 (PB—294631) **Application of a total system mine simulator to coal stripping. volume V. application to an Illinois mine. Open file report (final) 30 June 1975-31 March 1977.** Ramani, R.V.; Bandopadhyay, S.; Manula, C.B. (Pennsylvania State Univ., University Park (USA). Dept. of Mineral Engineering). 15 Jun 1977. 193p. NTIS, PC A09/MF A01.

In this report, the application of the open pit materials handling simulator (OPMHS) to a mine located in Illinois using bucket wheel excavator (BWE) and a stripping shovel in tandem for overburden removal is described. The specific objective of the study is to demonstrate the application of the simulator to analyze mine planning and scheduling problems and to generate and analyze alternatives for increased production. On the basis of the simulations it was concluded that the maximum productive capacity of the system in raw coal was around 3,000 tons per shift. At this production level, the equipment combination and availability also satisfy the match requirements for the stripping shovel and the BWE, and the overburden and coal removal systems. Several alternatives requiring new equipment are proposed and analyzed for increasing production.

11171 (PB—294632) **Application of a total system surface mine simulator to coal stripping. volume VI. an application to a modified contour-area mine. Open file report (final) 30 June 1975-31 March 1977.** Ramani, R.V.; Phelps, L.B.; Manula, C.B. (Pennsylvania State

Univ., University Park (USA). Dept. of Mineral Engineering). 19 Aug 1977. 220p. NTIS, PC A10/MF A01.

In this report, the application of the open pit materials handling simulator to a mine located in Ohio using a large stripping dragline, and truck and front-end loader is described. The specific objective of the study is to demonstrate the application of the simulator to mine planning and coal production. On the basis of the simulations, it was concluded that the production from the haulback operation should be increased to accommodate improvements in both the stripping dragline's availability and mean cycle time. Several alternatives were studied for the best use of equipment if the present operating parameters could not be improved upon.

11172 (PB—294633) **Application of a total system surface mine surface mine simulator to coal stripping. volume VII. application of OPHMS to a Southwestern surface mine. Open file report (final) 30 June 1975-30 September 1977.** Manula, C.B.; Albert, E.K.; Ramani, R.V. (Pennsylvania State Univ., University Park (USA). Dept. of Mineral Engineering). 19 Oct 1977. 204p. NTIS, PC A10/MF A01.

In this report, the application of an open pit materials handling simulator to a Southwestern surface mine using draglines and front-end loaders is described. The specific objective of the study is to demonstrate the application of the simulator to analyze mine planning and to analyze alternatives for increased production. The simulator was verified by comparing long-term production figures to the simulated results from data collected on a mine visit. A short-term and a long-term alternative are studied with projected productivities and scheduling.

11173 (UCRL—82731) **In situ fracture related to energy and resource recovery.** Schock, R.N.; Hanson, M.E.; Swift, R.P.; Walton, O.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1979. Contract W-7405-ENG-48. 16p. (CONF-790709—19). Dep. NTIS, PC A02/MF A01.

From VII international AIRAPT conference; La Creusot, France (30 Jul 1979).

Many resources require fracturing of rock before recovery. This is often accomplished by energy deposition under in situ conditions. The mechanical properties of the medium, confining pressure, pore fluid pressure, temperature, and energy deposition rate are among the important factors leading to an understanding and prediction of fracture production. Recent experimental and modeling studies have improved understanding of the effects of confining pressure on explosive-induced fracturing in small-scale blocks, effect of timing of multiple explosives, rate of pressurization on hydraulic fracture production, changing material properties on hydraulic pressure-produced fracture initiation and orientation, and material properties on rubble behavior after fracturing.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 11045, 11084, 11120, 11367

11174 (BNL—26941) **Atomization of coal slurry jets.** Butcher, T.; Pucci, A.; Krishna, C.R. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 13p. (CONF-791160—1). Dep. NTIS, PC A02/MF A01.

From 2. international symposium on coal-oil mixture combustion; Danvers, MA, USA (27 Nov 1979).

In the atomization of liquids the first step is the spreading of the liquid into thin sheets or columns either by fluid momentum or gas-fluid interaction. The thin sheets or columns will then breakup into droplets under the action of surface tension. The simplest case of this is the breakup of a liquid jet and as a step towards understanding the atomization of coal-oil mixtures this has been studied. The clasic work which has been done for liquid jets has been reviewed and repeated in part for coal-oil and coal-water mixtures. Jet length and drop size have been examined for water and No. 2 oil slurries up to 30% concentration. The relevance of this work for atomization is discussed and preliminary data from an air-atomized nozzle is presented for illustration.

11175 (IMMR—40-RRR5-78, pp 31-36) **Energy transportation in Appalachia.** Pixton, C.E. Dec 1978.

From 4. Kentucky coal refuse disposal and utilization seminar; Pineville, KY, USA (6 Jun 1978).

Transportation, in one form or another, is part of every Btu of energy entering or leaving the Appalachian Region. Rarely is it possible for both producers and users of energy commodities to be in such close proximity that transport is eliminated completely. In some instances, because of the distances moved, transport costs may equal or be greater than the costs of production. In all instances, improved transport efficiency benefits the energy producers by lowering the market price in a competitive situation. These same efficiencies also benefit energy users by lowering the purchase price of the energy commodity. Two recent studies, sponsored by the Appalachian Regional Commission, examine the transport of energy commodities within the Region. The first study concludes that, with the exception of the upper Ohio River and its tributaries, there are no major mainline capacity problems in the three modes considered - rail, water, and pipeline. Any increased energy production and/or consumption of energy will trigger the need for increased capital investment in each of these modes, however. The second study highlights the plight and deterioration of many public roads in the Region being used for coal haulage. An estimated immediate capital investment of $4 to 5 billion is needed to upgrade roads and bridges to adequate standards within the Region. Increased energy production of 35% above the 1974 figures would raise the improvement bill by $1 billion as more roads and bridges become impacted.

11176 (IMMR—40-RRR5-78, pp 37-40) **Kentucky's coal transportation highway system.** Grayson, C.G. (Kentucky Dept. of Transportation, Frankfort). Dec 1978.

From 4. Kentucky coal refuse disposal and utilization seminar; Pineville, KY, USA (6 Jun 1978).

During the fall of 1977, we found that some 6814 miles of Kentucky roads, streets and highways were being used to transport coal. Approximately 87%, or 5895 miles of that total, was on the state maintained system of highways. That leaves only 919 miles, or about 13%, that were not state maintained. Over 6000 miles, or about 88% of the total, were in the coal producing counties. Slightly over 800 miles, or about 12 percent of the total, were in noncoal producing counties. A map illustrates the extent of the coal transportation highway systems. What, then, does our inventory of the roads, streets and highways used to haul coal indicate. It shows that our original estimates of improvement costs were conservative. On the basis of this detailed inventory, it appears that the funding requirement to accommodate the heavy coal loads should be more like $5 billion.

11177 (IMMR—40-RRR5-78, pp 55-56) **Refuse dewatering by centrifuges.** Iwasyszyn, T. (Centrifugal and Mechanical Industries, Inc., St. Louis, MO). Dec 1978.

From 4. Kentucky coal refuse disposal and utilization seminar; Pineville, KY, USA (6 Jun 1978).

Refuse dewatering with centrifuges is rather new to the coal industry. With all new EPA Regulations regarding black water, ponds, etc., the coal industry started looking fo an economical system to process refuse. In order to clean up the refuse and make it more economical to handle, they had to dry it. In order to dry the refuse, a centrifuge had to be used on the plus 28 mesh. There are two types of refuse centrifuges. They are vertical and horizontal vibratory type centrifuges. The effluent from the refuse centrifuge, with some fine refuse, goes to a thickner for minus 28 mesh dewatering.

11178 (IMMR—40-RRR5-78, pp 57-63) **Application of vibrating equipment for storage and handling of coal filter cake and refuse.** Roessler, M.L. (Vibranetics, Inc., Louisville, KY). Dec 1978.

From 4. Kentucky coal refuse disposal and utilization seminar; Pineville, KY, USA (6 Jun 1978).

With today's increasing demand for coal, new techniques in material handling are being developed and used, in order to keep producing coal without costly and timely shut-downs. One of the most difficult material handling situations within coal preparation is the storage and moving of refuse. And because of increased production of coal and new mining techniques, specifically, continuous miners, the percentage of refuse has increased to extremely high levels. Several years ago the average percentage of refuse to total coal production ranged between 22% and 35%. Now, some mines produce up to 50% refuse. Refuse is generally moved into storage and then hauled away by truck or aerial trams to a disposal area. It is the storage area that creates the most difficult material handling problems, since refuse is not a free-flowing solid material. The use of vibrating equipment for moving refuse is relatively new. Vibrating bin dischargers were first installed in 1972, but now have become common equipment for use on refuse storage bins. The attempted use of electro-magnetic type vibrating feeders for handling refuse has developed with limited success depending upon the refuse's characteristics. However, with the advent of the all-electric, adjustable rate, natural-frequency, electro-mechanical feeder in 1966, this feeder is becoming more commonly used when controlled rate of refuse is required. When selecting vibrating equipment, one must always consider the worst condition of refuse to be handled. The common everyday application may be normal refuse, or a mixture of refuse and filter cake. However, during the end of shifts, or during a break-down, the thickeners may still run, and you might end up with pure filter cake in your storage bin or on your vibrating feeder. Therefore, consider all situations before selecting the equipment.

11179 (JPL-PUBL—78-56, pp 123-126) **Prospects for coal slurry pipelines in California.** Lynch, J.F. (Energy Transportation Systems, Inc., San Francisco, CA). 15 Aug 1978.

From Conference on coal use for California; Pasadena, CA, USA (9 May 1978).

The study looked at several movements of coal to markets throughout the Western states and reached some pertinent conclusions including: pipelines are more economical than rail for long-distance, large-quantity hauls; for other situations, pipelines are competitive on a case-by-case basis. The key to economical use of Western coal lies in transportation costs which will run as high as 70% of the delivered cost of fuel. Coal slurry pipelines offer the technological breakthrough in economies of scale necessary to transport coal over long distances. In the Far West, with substantial distances between coal reserves and the end-user, the economies of scale gain added significance. As proven time and time again, the larger the system, the more competitive the pipeline over rail transport. This conclusion has been confirmed by the previously mentioned OTA study. In contrast, there is practically no economy of scale for the railroads which will carry the burden of most coal transport. A unit train set of 110 cars at 100 tons per car will move 11,000 tons per trip. For a 1000 mile movement one train set would move about 400,000 tons per year. Additional tonnage above this level merely calls for additional train sets. Pipelines in general enjoy a much lower inflation sensitivity than rail transportation because 70% of its costs are fixed. Once the pipeline is installed, only 30% of operating expenses are subject to increases in the cost of labor, electric power and supplies. In the case of rail, the reverse is true. Between 75 and 80% of its costs are variable with inflation. For instance, more than half of rail expenses are tied to the cost of labor and are consequently subject to the volatile impact of labor disputes and strikes, not to mention higher operating and maintenance expenses. (LTN)

11180 (LA—8173-MS) **Assessment of trace element contamination of the drainages from coal cleaning wastes.** Wagner, P.; Williams, J.M.; Wewerka, E.M.; Bertino, J.P.; Wangen, L.W.; Wanek, P.L.; Thode, E.F. (Los Alamos Scientific Lab., NM (USA)). Dec 1979. Contract W-7405-ENG-36. 19p. Dep. NTIS, PC A02/MF A01.

The mineral wastes produced by coal cleaning contain in abundance of toxic or potentially harmful trace elements. Although it has been well established that many of these toxic elements are present in the drainages from coal waste dumps, little is known about the quantities released into the environment from this source. The objectives of this research program are to assess the nature and magnitude of the trace elements in the effluents from coal refuse materials, and to develop appropriate environmental control technologies as needed. In this paper we present recent experimental results from this program concerning the chemistry and aqueous leaching behavior of the trace elements in high sulfur coal cleaning wastes. The emphasis is on the interpretation of the experimental data that has led to the identification of trace elements in coal refuse effluents consistently present in unacceptable quantities, and the development of environmental control strategies designed to abate or mitigate the problems of environmental concern that have resulted from these refuse drainages. Experiments have been performed to simulate the intermittent rainfall and weathering to which refuse dumps are subjected. These researchers have revealed that this alternate oxidation and leaching of the pyrite in the refuse is a most effective way to generate acid leachates and indeed these intermittently leached coal waste piles pose a far greater pollution threat, in terms of both quantity and time, than those wastes that are always in contact with water or otherwise isolated from air.

11181 (PB—293423) **An analysis of the transport of coal and oil to the Lake Champlain Basin. Final report.** Heindel, C. (Lake Champlain Basin Study, Burlington, VT (USA)). May 1978. 82p. NTIS PC A05/MF A01.

The objective of this report was to prepare an analysis of the various types of oil and coal transport in the Lake Champlain Basin. The three types of transport presently in use are: (1) barges, which utilize the Hudson River, the Champlain Canal, and Lake Champlain; (2) trucks, coming from oil suppliers in the Albany, New York area, and several locations in New England; and (3) railroads, transporting petroleum products from the Albany, New York area. Economic and environmental factors such as projections relating to oil use and storage, potential oil spill concerns, distance, and capacity of carrying units were also considered.

11182 (PB—294072) **Coal slurry pipelines: progress and problems for new ones.** (Army Missile Research Development and Engineering Lab., Redstone Arsenal, AL (USA). Army High Energy Laser Directorate). 20 Apr 1979. 34p. NTIS, PC A03/MF A01.

This report summarizes information on some of the key issues concerning coal slurry pipelines--pipelines that carry a mixture of coal and water--and whether pipeline companies need Federal eminent domain legislation to help acquire rights-of-way along proposed routes. It discusses the current status of seven proposed pipelines and points out that at least four may be built by the mid-1980's even without Federal eminent domain legislation. The report highlights some recent changes that have occurred since the Coal Pipeline Act of 1978, proposed in the 95th Congress, was defeated in July 1978.

11183 (SR—114) **Computer analysis of coal preparation plant economics and equipment selection.** Zigmond, R.D.; Ramani, R.V.; Frantz, R.L. (Pennsylvania State Univ., University Park (USA)). 26 Oct 1979. 355p. Pennsylvania State Univ., University Park, PA.

A computer program has been developed for determining the capital and operating costs for coal preparation plants. The logic of the computer program is based upon a survey of existing preparation plants, operators, plant contractors, equipment manufacturers, and consulting firms. This survey provided information on plant performance, order-of-magnitude costs, and costing procedures. Additionally, an extensive cost data file for the major capital equipment in coal preparation plans has been developed. Generalized and representative circuit flowsheets that portray real-world situations were analyzed. With this computer program, it should be possible to: (1) determine preliminary costs for most preparation plant flowsheets; (2) investigate the costs of each level of preparation; (3) study the effects that size distribution would have on costs; (4) fluctuate the specific gravity of separation to optimize both capital and operating costs; (5) compare the costs of different processes and procedures; and (6) help design the optimum flowsheet by making the above comparisons. The basic inputs to the program are: (1) size consist percentages of the raw feed; (2) yields at the designed washing specific gravity by size; and (3) unit operations in the plant to be designed. The ouptut of the program includes: (1) the size of the equipment associated with each unit operation and (2) the detailed breakdown of capital and operating costs. In addition to the development of the pogram, this study reviewed prior research and published literature related to preparation plant design, anc coal preparation plant capital and operating costs.

11184 **Agglomeration of coal fines.** Clayfield, E.J.; Pinnington, C.; Cannon, M.J.; Sant, P. (to Shell Oil Co.). US Patent 4,153,419. 8 May 1979. Priority date 3 Dec 1976, United Kingdom of Great Britain and Northern Ireland (UK), 6p.

Process for the agglomeration of coal fines characterized by the staged addition of an aqueous emulsion of an oil fraction to an aqueous slurry of the fines.

11185 **Test installation for studying erosion-corrosion of metals for coal washing plants.** Hoey, G.R.; Dingley, W.; Wiles, C.T. Ottawa, Ontario; Minister of Supply and Services Canada (1979). 14p. (CANMET—79-19). Canmet Publication Office, 555 Booth St., Ottawa, Ontario.

A test installation was constructed for investigating erosion-corrosion of metals by coal-water slurries. Erosion-corrosion tests of mild steel panels were conducted using slurries of alundum, quartz, washed coal and coal refuse. Wear rates were found to depend on type of abrasive, particle size and water conductivity and were reduced by cathodic protection and inhibitors. Cathodic protection of mild steel in coal slurries containing sulphate ion reduced wear by 90% and 86% for stationary and rotating panels, respectively. This study has demonstrated that the successful application of corrosion control techniques would reduce metal wastage in coal washing plants. The test installation is considered suitable for developing the techniques.

COMBUSTION

REFER ALSO TO CITATION(S) 11079, 11199, 11200, 12268

11186 (ANL/CEN/FE—79-9) **Regeneration of sulfated limestone from FBCs. Quarterly report, April-June 1979.** Johnson, I.; Moulton, D.S.; Nunes, F.F.; Smyk, E.B.; Swift, W.M.; Teats, F.G.; Jonke, A.A. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 52p. Dep. NTIS, PC A04/MF A01.

These studies are concerned with the development of processes for the regeneration of sulfated limestone from fluidized-bed combustors. The results of cyclic combustion/regeneration experiments on two limestones are reported. In these studies the behavior of a low reactivity limestone, Germany Valley, during cyclic combustion/regeneration was studied; regeneration did not significantly change its reactivity. Studies of a high reactivity limestone, Greer, at lower (1050°C vs 1100°C) regeneration temperatures indicated an apparent improvement in performance. The mass and energy balance-constrained model for the continuous combustion-regeneration process was modified to allow more complete specification of the sorbent properties. The results of studies of a process for the recovery of elemental sulfur from SO_2 involving reaction with fly ash or coal ash-coal combinations are reported. The residual carbon in the fly ash was found to be an effective reductant for the SO_2 and high purity sulfur was obtained.

11187 (DOE/NASA/2593—79/11) **Status of the DOE/NASA Critical Gas Turbine Research and Technology Project.** Clark, J.S. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1980. Contract EF-77-A-01-2593.

20p. (NASA-TM—79307; CONF-800302—4). Dep. NTIS, PC A02/MF A01.

From 25. international gas turbine conference; New Orleans, LA, USA (9 Mar 1980).

The purpose of the DOE/NASA CRT (Critical Research and Technology) Project at the Lewis Research Center is to provide an R and T data base for utility gas turbine systems burning coal-derived fuels. Coal-derived fuels present difficult problems in combustion (because of the high organically-bound nitrogen in the fuel), and materials (because of the trace metal contaminant levels in the fuels, leading to corrosion and deposition in the turbine hot section). The combustion task includes: (1) an effort to model the rich-lean combustion process, to predict NO/sub x/ emissions; (2) a two-stage flame tube experiment to study the effects of combustion operating conditions and fuel properties on NO/sub x/ conversion; (3) scaled combustor tests to evaluate the NO/sub x/-reduction potential of several staged-combustion concepts; and (4) a catalytic combustion task. The materials-corrosion resistance effort attacks the problem on three sides. First, experiments were run to determine the corrosivity effects of trace metal contaminants (and potential fuel additives) on gas turbine materials and these results were correlated in a corrosion-life prediction model. Actual fuels were burned in a burner rig hot corrosion test to verify the model. Second, a deposition prediction model was assembled and compared with results of actual coal-derived fuel deposition tests. Third, thermal barrier coatings were tested to determine their potential for protecting gas turbine hardware from the corrosive contaminants. Several coatings were identified with significantly improved spallation-resistance (and, hence, corrosion-resistance).

11188 (FE—2473-30) **Industrial application of fluidized-bed combustion. Phase I. Quarterly technical progress report, January-March 1979.** (Combustion Engineering, Inc., Windsor, CT (USA)). 1979. Contract EX-76-C-01-2473. 97p. Dep. NTIS, PC A05/MF A01.

Sub-Scale Unit shakedown and over half of the test program were successfully completed. The results provided significant data for the final design of the demonstration plan. Final approval of the Prevention of Significant Deterioration report was received the week before site preparation was scheduled to begin. Federal EPA review of the report required an extended period of time, much more than originally estimated. Final design of the demonstration plant has continued to progress towards completion. Engineering specifications are being prepared on the building services. Preparation of arrangement and detail drawings for much of the plant systems is underway. A cost comparison study between a pulverized coal and fluidized bed fired units has been continued. The construction of the demonstration plant has begun as scheduled. Site preparation was initiated on March 26, 1979. Combustion Engineering has manned the job and is providing coordination of field activities. Work continues to develop a comprehensive shakedown and testing program for the demonstration plant. Objectives of the program are (1) to verify equipment performance and record detailed operational history and (2) to establish optimum operating conditions and procedures for maximum continuous operation, sustained partial load operation, variable load operation and cyclical operation. Testing will be scheduled to support these objectives within the restraints of the activity and program schedule.

11189 (JPL-PUBL—78-56, pp 20-32) **Using coal inside California for nonelectric applications.** Oxley, J.H. (Battelle Columbus Labs., OH). 15 Aug 1978.

From Conference on coal use for California; Pasadena, CA, USA (9 May 1978).

An analysis of nonelectric applications for coal will include a review of present energy consumption patterns in the manufacturing, transportation, and residential sectors. The properties of coal that affect its substitution into these market sectors will be discussed. Specific needs and concerns of Californians will be delineated. Present nonelectric consumptive uses of coal in California will be outlined. Current world-wide progress concerning increased industrial use of coal will then be shown. An overview will be given of the options to protect the environment from the direct use of coal, especially from the standpoint of sulfur control; and a time frame for commercialization will be projected. Finally, possible desired changes in energy use patterns over the next fifty years will be proposed.

11190 (N—79-20487) **Simulation of fluidized bed coal combustors. Final report.** Rajan, R. (West Virginia Univ., Morgantown (USA)). Feb 1979. 215p. NTIS, PC A10/MF A01.

The many deficiencies of previous work on simulation of fluidized bed combustion (FBC) processes are presented. An attempt is made to reduce these deficiencies, and to formulate a comprehensive FBC model taking into account the following elements: (1) devolatilization of coal and the subsequent combustion of volatiles and residual char; (2) sulfur dioxide capture by limestone; (3) NOx release and reduction of NOx by char; (4) attrition and elutriation of char and limestone; (5) bubble hydrodynamics; (6) solids mixing; (7) heat transfer between gas and solid, and solid and heat exchange surfaces; and (8) freeboard reactions.

11191 (ORNL/TM—7141) **One-dimensional model of fluidized-bed combustor dynamics.** Perez, R.B. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 51p. Dep. NTIS, PC A04/MF A01.

Starting from Soo's basic multiphase equations, a set of one-dimensional time-dependent hydrodynamic and enthalpy equations was developed for a fluidized bed reactor by averaging over its cross sectional area. The following effects were not considered in the derivation of the FBC equations: forces to accelerate the apparent mass of the solid particle, basset force, heat exchange by radiation between solids and fluid or within each phase, and electrodynamic effects. Within these restrictions, the material developed here forms the basis for a sequel to this report devoted to the development of stability studies and to the application of stochastic methods for FBC surveillance.

11192 (PB—290532) **Formation of Nox and other products from chemically bound nitrogen in coal combustion. Final report, 1 April 1975-30 September 1977.** Blair, D.W.; Wendt, J.O.L. (Exxon Research and Engineering Co., Linden, NJ (USA). Government Research Lab.). May 1978. 159p. NTIS, PC A08/MF A01.

An experimental and theoretical investigation of the fate of fuel-nitrogen in coal particle combustion focused upon the initial pyrolysis phase of the process. The experimental work measured the gaseous species evolved during simulated combustion pyrolysis and the total mass and total nitrogen lost from the solid phase during pyrolysis as functions of temperature and heating rate. Theoretical models of coal particle pyrolysis were formulated and tested on high-speed computing equipment. This work interacted strongly with the experimental effort. A new non-gravimetric method for determination of time-resolved volatilization rates of coal particles was developed. The experimental method consisted of linking the pyrolysis reactor directly to a thermal conductivity detector with a capillary tube, sweeping the pyrolyzate through the detector with helium carrier gas, and displaying the time-resolved detector signal on a strip chart. This signal was then numerically inverted to give the mass evolution rate from the particle.

11193 (PETC—10574-6) **Rheological properties of Methacoal suspensions formulated from Texas lignite. Final report.** Darby, R. (Texas A and M Univ., College Station (USA)). Aug 1979. Contract EF-77-G-01-2725. 81p. Dep. NTIS, PC A05/MF A01.

Rheological properties of Methacoal suspensions were evaluated as a function of shear rate, solids volume fraction, particle size distribution, and initial lignite moisture content. The suspensions were mostly quite stable, highly shear thinning, and the apparent viscosity increased exponentially with solids fraction. The viscosity data were fit by various models, and the model parameters were found to correlate with the fraction of fines in the suspension. Final correlations showed the apparent viscosity to be a minimum at a particular fraction of fines in suspension, the value of which depends upon the shear rate. The extent of this minimum is more pronounced as the lignite moisture content is reduced. Stable Methacoal suspensions were less compact and more fluid than comparable water suspensions. It was demonstrated that larger quantities of Methacoal suspensions with good stability and flow properties could be produced using a continuous Dispax homogenizer. Representative tube flow data were obtained for some of these suspensions in a specially constructed tube flow viscometer in laminar flow, which increased the effective range of viscosity measurements by over an order of magnitude. A bench scale pipe flow facility has been constructed incorporating eight tubes with diameters up to 1 1/2 in., each 40 ft. long, capable of obtaining data in the turbulent flow range as well. This facility can operate either continuously using a centrifugal slurry pump, or on a once through basis using pressurized air drive.

11194 **Stabilized fuel slurry.** Marlin, L.A. (to Interlake, Inc.). US Patent 4,153,421. 8 May 1979. Filed date 17 May 1976. 10p.

A method of preparing a stabilized fuel slurry is disclosed wherein a petroleum fuel oil is mixed with run of the mine coal and with a polysaccharide emulsifier capable of forming water internal-oil high external phase emulsion. The slurry is mechanically mixed to comminute the coal to produce a stabilized fuel slurry with coal particles having diameters as large as about 1/4 inch. The slurry is injected through lances into a blast furnace, the lances provided concentric streams of slurry and steam. The slurry may also be used in other fuel burning furnaces such as boilers, cement kilns, etc.

11195 **Dry coal feed systems for combustion reactors.** Jukkola, W.W.; Svencer, R.E. (to Dorr-Oliver Inc.). US Patent 4,152,110. 1 May 1979. Filed date 3 Jan 1978. 10p.

Systems for the comminution, drying and dry feed of coal for combustion in fluid bed calciners, incinerators, or other combustion systems.

11196 **Coal suspensions in organic liquids.** Sawyer, E.W. Jr. (to International Telephone & Telegraph Corp.). US Patent 4,147,519. 3 Apr 1979. Filed date 27 Jun 1977. 8p.

Suspensions of coal dust powder in fuel oil are stabilized against sedimentation by an additive that makes them viscous under conditions of low shear in order to keep the coal in suspension under static conditions while exhibiting relatively low viscosity under high shear conditions to facilitate pumping through long range pipelines by the combination of a suitable surfactant with a gelling grade clay suspending agent.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 11035, 11101, 11838

11197 (ANL/SPG—10) **Survey of electric utility demand for coal.** Asbury, J.G.; Caruso, J.V.; Kouvalis, A.; Maslowski, C.S. (Argonne National Lab., IL (USA)). Aug 1979. Contract W-31-109-ENG-38. 356p. Dep. NTIS, PC A16/MF A01.

This report presents the results of a survey of electric utility demand for coal in the United States. The sources of survey information are: (1) Federal Energy Regulatory Commission Form 423 data on utility coal purchases during the period July 1972 through December 1978 and (2) direct telephone survey data on utility coal-purchase intentions for power plants to be constructed by 1992. Price and quantity data for coal used in existing plants are presented to illustrate price and market-share trends in individual coal-consuming states during recent years. Coal source, quality, quantity, and transportation data are reported for existing and planned generating plants.

11198 (DOE/EIA—0127/4Q(78)) **Pennsylvania anthracite weekly production, 1978.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 1978. 25p. Dep. NTIS, PC A02/MF A01.

This document comprises a compilation of data on Pennsylvania anthracite production (weekly), development (monthly), and exports. (DLC)

11199 (IMMR—40-RRR5-78, pp 27-30) **Economic and social implications of the coal industry.** Newman, M. (Pennsylvania State Univ., University Park). Dec 1978.

From 4. Kentucky coal refuse disposal and utilization seminar; Pineville, KY, USA (6 Jun 1978).

In summary, the Committe recommended that attention be directed toward six major areas of uncertainty and concern in addition to the need for an improved data, monitoring and projection system. (1) Air pollution health effects: concern focuses on respirable acid particles and on the atmospheric transformation and transport of stack emissions. (2) Coal mine worker health and safety: concern focuses on monitoring the enforcement and health effects of the 1977 law and on the effects of new equipment (particularly diesel) in the mines. Training of new miners was of concern as well. (3) Global effects of atmospheric carbon dioxide: concern was expressed for the possibility of substantial climate changes within 50 years that could be disruptive of worldwide socio-political systems. (4) Trace elements: coal use releases, and environmental protection devices concentrate, toxic elements that can leach into water or enter the food chain. (6) Reclamation of arid land: mining by surface methods in arid areas may create areas that cannot be restored.

11200 (JPL-PUBL—78-56) **Proceedings of the conference on coal use for California.** (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Aug 1978. Contract ET-78-I-01-3056. 523p. (CONF-7805183—). Dep. NTIS, PC A22/MF A01.

From Conference on coal use for California; Pasadena, CA, USA (9 May 1978).

These proceedings contain the papers, statements, and panel session transcriptions that resulted from the Coal Use for California Conference that was held at Pasadena, California from 9 through 11 May 1978. The conference brought together approximately 400 specialists, students, interest groups and general public for the examination of technological, institutional, and social issues surrounding coal use for California and the identification of attendant constraints, impediments, advantages, and target opportunities. The expertise of the participants cover a wide range of subject matter and that includes systems examination of coal opportunities, energy demand forecasting, environmental aspects of coal use, coal supply and transport, viewpoint of neighboring states, air pollution control, direct firing, coal gasification and liquefaction technologies, economics of coal use, and the regulatory systems. Papers have been entered individually into the data base. (LTN)

11201 (NTISUB/E—282-002) **Chinese coal industry: prospects over the next decade. Research paper.** (Central Intelligence Agency, Washington, DC (USA)). Feb 1979. 17p. NTIS PC E02/MF A01.

The People's Republic of China plans to double coal output to more than 1 billion tons by 1987. This paper examines the feasibility of the coal target by discussing: (a) China's coal resources and recent trends in output; (b) the present and prospective patterns of coal consumption; (c) the strategy being adopted by the leadership to increase capacity, output, and the level of technology; and (d) the practical problems China will face over the next decade in implementing this strategy. The report concludes that China will fall short of the 1987 coal target. Even though planned targets may not be met, China probably will not face critical shortages of coal over the next decade, in part because major consumers also will be operating below planned levels. Even with shortfalls, the coal industry will be a leading beneficiary of China's new modernization program and openness to foreign assistance.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 11082, 11199, 12467, 12571, 12659, 12664, 12665, 12667, 12687

REGULATIONS

REFER ALSO TO CITATION(S) 11131

11202 (JPL-PUBL—78-56, pp 7-9) **Coal for Califorina: overview.** Mills, A.G. 15 Aug 1978.

From Conference on coal use for California; Pasadena, CA, USA (9 May 1978).

The author feels that the US is at a crossroads in energy policy and that what is done now is going to affect energy activities for years ahead into the next century. Of course, the choices are not easy and within California energy conflict are seen that involve Federal leasing, interstate electricity transmission, energy siting, water and environmental activities, and all of these are in different stages of resolution. The complex system requires that in California planning consider such things as developing conventional energy such as coal, alternative energy such as geothermal, regulating energy companies, protecting the environment, and planning national, regional, and state activities.

PETROLEUM

GEOLOGY AND EXPLORATION

11203 (COO—4392-2) **Organic geochemistry of continental margin sediments.** Hunt, J.M.; Whelan, J.K.; Huc, A.Y.; Pratt, M. (Woods Hole Oceanographic Institution, MA (USA). Dept. of Chemistry). 1979. Contract EG-77-S-02-4392. 65p. Dep. NTIS, PC A04/MF A01.

Well cuttings from two offshore Gulf Coast stratigraphic test wells (South Padre and Mustang Island) have been analyzed for C_7-C_{15} hydrocarbon distributions by thermal distillation-pyrolysis GC, for C_1-C_7 hydrocarbons by headspace analysis and for C_{15}^+ hydrocarbons by extraction. The results from the South Padre well show that the threshold of intensive hydrocarbon generation starts around 10,000 feet and peaks around 14,000 feet. The distribution of individual homologs within each hydrocarbon group indicates that the more volatile members are migrating upward from the generation zone. Thus, n-pentane (C_5) peaks at 10,000 feet, and the higher homologs, C_5, C_6, C_7, C_8 and C_{10} peak at successively greater depths to 15,000 feet. Benzene also peaks before toluene which peaks before the xylenes. This phenomena was not observed in the Mustang Island well where organic carbon contents and hydrocarbon yields were lower, apparently too low to induce migration. C_1-C_7 hydrocarbon distributions also were studied by the headspace technique in offshore samples from the East Coast, Gulf of California and Gulf of Maine. Hydrocarbon yields from wells east of Cape Hatteras and on the Blake-Bahama Plateau were much lower than in most other areas analyzed to date. Some Gulf of California samples had high gas yields due to hydrothermal intrusions and igneous dikes raising sediment temperatures. Gulf of Maine samples were unique in having no aromatic hydrocarbons.

11204 (ORO—5198-T6) **DOE Eastern Gas Shales Project: Dunkirk study. Quarterly report of technical progress, July, August, September 1979.** Harper, J.A.; Abel, K.D.; Piotrowski, R.G. (Pennsylvania Dept. of Environmental Resources, Harrisburg (USA)). 1979. Contract EY-76-S-05-5198. 2p. Dep. NTIS, PC A02/MF A01.

Ten cross sections were completed and drafted, and blueline copies were sent to DOE, Morgantown, WV, for review. These cross sections were used as the basis with which all other logs in the

study area were correlated. The data has been encoded from 228 logs that were used. Two isopach, 2 structure contour, and 3 lithofacies maps have been completed and are awaiting drafting. A production and show map has been drafted and blueline copies were sent to DOE, Morgantown, WV, for review. The schedule of work was delayed due to the state budget problems the need to correct work previously completed and sent to DOE, Morgantown, WV, and lack of a reproduction contract.

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 11227, 11836

11205 (DOE/EDP—0048) **Environmental development plan enhanced oil recovery.** (Department of Energy, Washington, DC (USA). Office of Fossil Energy). Nov 1979. 80p. Dep. NTIS, PC A05/MF A01.

The Division of Fossil Fuel Extraction, within the Office of Energy Technology, is responsible for DOE's Enhanced Oil Recovery (EOR) research, development, and demonstration program. The EOR program activities are designed to accelerate the development of environmentally acceptable technologies for the tertiary recovery of oil from economically depleted and heavy oil reservoirs. The major project areas identified for the EOR Program are thermal processes (steam injection and in situ combustion), miscible processes (carbon dioxide injection), and chemical flooding processes (micellar-polymer flooding and improved waterflooding). In order to promote the prompt commercial application of the developed technology, DOE has recently established a commercialization task force to study the technology and its potential application and to develop initiatives that can be undertaken by the Federal Government to accelerate the commercial application of this technology. This effort is being carried out by the Office of Oil and Gas in the Division of Resource Applications. Details of this program are described in detail in Chapter III of this document. The major environmental concerns affecting the EOR technology program include air quality degradation, aquifer contamination, water availability, and occupational health and safety considerations. The major concerns and the environmental, health, and safety (EH and S) research requirements are summarized.

11206 (DOE/MC/08442—T1) **Corrosion due to use of carbon dioxide for enhanced oil recovery.** DeBerry, D.W.; Clark, W.S. (SumX Corp., Austin, TX (USA)). Aug 1979. Contract AC21-78MC08442. 74p. Dep. NTIS, PC A04/MF A01.

Injection of carbon dioxide (CO_2) is a promising method for recovering large amounts of oil that cannot be recovered by conventional (primary and secondary) technology. As with any relatively new technology, there are aspects of CO_2 injection that, without adequate assessment, could discourage its use. One of these aspects is the potential for increased corrosion of oil field equipment that could result from CO_2 injection. Purpose of this study is to document the specific effects of CO_2 on corrosion and to identify promising methods for controlling corrosion in fields using CO_2 injection.

11207 (DOE/PE—4973) **Energy supply strategy: getting technology commercialized, shale oil and enhanced oil recovery.** Steger, J.E.; Sullo, P.; Michaelis, M.; Nason, H.K. (Rensselaer Polytechnic Inst., Troy, NY (USA); Little (Arthur D.), Inc., Cambridge, MA (USA); Research Corp., St. Louis, MO (USA). Industrial Research Inst.). Dec 1979. Contract EJ-78-S-02-4973. 140p. Dep. NTIS, PC A07/MF A01.

Purpose is to identify factors inhibiting the near-term investment of industrial funds for producing oil from shale and through enhanced oil recovery, and to estimate the investment and production which would result if these deterrents were removed and suitable incentives provided. The barriers are discussed under the following categories: economic, environmental, institutional/regulatory, and technical. (DLC)

11208 (SAN—1396-T1) **Caustic waterflooding demonstration project: Ranger Zone, Long Beach Unit, Wilmington Field, California. Third annual report, June 1978-May 1979.** Mayer, E.H. (THUMS Long Beach Co., CA (USA)). Dec 1979. Contract EF-77-C-03-1396. 229p. Dep. NTIS, PC A11/MF A01.

A caustic-enhanced waterflooding pilot test is being conducted in the Ranger Reservoir of the Long Beach Unit, Wilmington Field, California. Evaluation of entrapment and entrainment caustic flooding in Ranger Zone cores was continued. The caustic-only (entrapment) core floods failed to demonstrate improved behavior. Based on the unfavorable results of all tests of the entrapment mechanism, further laboratory work and flooding in the pilot with caustic alone have been eliminated from the project's plans. Some of the year's caustic-salt (entrainment) core floods in contrast showed both substantial recovery and WOR improvement. The poorer overall entrainment core flood results obtained in the year may be due to the core material, a smaller preflush volume used or the crude oil employed. Core flood testing where sodium silicate is substituted for some of the sodium hydroxide, was continued. The primary set of caustic water-oil dehydration tests was completed. The test softening of produced waters was completed and the results evaluated; produced water softening was found to be an economically feasible alternative to the use of fresh water. The preflush injection facilities became operational in January 1979 with the pilot's preflush officially begun April 15, 1979. The alkaline injection facility was expanded in scope to permit use of both sodium silicate and sodium hydroxide; its completion in late 1979 is anticipated with the alkaline-salt injection scheduled to begin at that time. The base case reservoir simulator prediction of the pilot under continued waterflooding was completed. This prediction provided the base line from which incremental alkaline flood production will be determined, as the test has now been declared a qualified tertiary enhanced recovery project by DOE's Economic Regulatory Administration. Major well repair/redrill work continued to be necessary exceeding earlier increased cost estimates.

11209 (SAND—79-1986) **Packer induced stresses during hydraulic well fracturing.** Warren, W.E.. (Sandia Labs., Albuquerque, NM (USA)). Dec 1979. Contract EY-76-C-04-0789. 36p. Dep. NTIS, PC A03/MF A01.

Well bore stresses induced by inflatable packers during hydraulic fracturing operations are investigated. The geologic formation is modeled as an unbounded homogeneous isotropic linear elastic solid containing an infinitely long circular cavity, while the packer is modeled as a semi-infinite thin walled circular cylindrical shell. For given packer properties, these induced stresses are shown to depend on the difference between packer pressure and fracturing pressure and can become significant. Typical numerical results are obtained and presented graphically. Analytical approximations for the maximum values of these stresses are also presented. While these effects are of no importance in the usual applications of hydraulic fracturing to enhance oil and gas recovery, they are crucial in attempts to estimate in-situ stresses from hydraulic fracturing pressure data. 7 figures

11210 **Ultimate recovery, rate of withdrawal, and maximum efficient rate (MER) for oil reservoirs.** Lohrenz, J.; Monash, E.A. pp 20-66 of Maximum efficient rate (MER) for petroleum reservoirs in the Outer Continental Shelf. Symposium proceedings. McFarland, J.W. (ed.). Houston, TX; University of Houston (1979).

From MER for petroleum reservoirs in the CCS symposium; Houston, TX, USA (29 Jan 1979).

A simple model is used to show that the ultimate recovery at thermodynamic exhaustion from the oil reservoir characteristically increases with rate of withdrawal when there is a water drive and decreases with rate of withdrawal when there is a time-dependent segregation drive. With both a water drive and time-dependent segregation drive, ultimate recovery exhibits a maximum with rate of withdrawal. Considering ultimate recoveries before thermodynamic exhaustion is reached, all reservoirs are rate sensitive, even those that are rate insensitive when ultimate recovery at thermodynamic exhaustion is considered. Production regulation of oil reservoirs can then be viewed as constraints on the choices available to the operator when he selects where to operate on the set of functions describing ultimate recovery versus rate of withdrawal with the limiting or cutoff rate as a parameter. (When the cutoff rate is zero, thermodynamic exhaustion occurs.) What any implementable production regulations must do then is to provide unambivalent mathematical rules delineating the constraints desired. Presently, there is no rationale for coherent production regulation using MER as provided for in law because these unambivalent policy rules are not given. Some set of unambivalent rules implementing the desired policies must be given before MER or any other production regulation schema can be reasonably implemented. 13 figures.

11211 **Some empirical methods for MER analysis.** Purvis, R.A. pp 67-94 of Maximum efficient rate (MER) for petroleum reservoirs in the Outer Continental Shelf. Symposium proceedings. McFarland, J.W. (ed.). Houston, TX; University of Houston (1979).

From MER for petroleum reservoirs in the CCS symposium; Houston, TX, USA (29 Jan 1979).

In principle, reservoir model studies could be used to determine MER and to provide criteria for surveillance of reservoir performance. However, in practice there is insufficient money and manpower to perform the detailed studies that would be required. The next best approach is to utilize simple models and empirical methods to locate the reservoirs in which rate has a significant effect on recovery. In addition to the methods discussed, a figure summarizes the factors the Energy Resources Conservation Board uses to make a qualitative assessment of the need for and level of MER. 12 figures.

11212 **Definitions of M.E.R. and efficiency in oil production: an economist's comments.** Ramsey, J. pp 95-106 of Maximum efficient rate (MER) for petroleum reservoirs in the Outer Continental Shelf.

Symposium proceedings. McFarland, J.W. (ed.). Houston, TX; University of Houston (1979).

From MER for petroleum reservoirs in the CCS symposium; Houston, TX, USA (29 Jan 1979).

The economic definition encompasses the engineering definition and in addition focuses attention on the valuation of resources used and of output gained. If the economist's definition is accepted, then the economist's definition of M.E.R., for example, Steven McDonald's paper in this conference, is the logical choice. However, the economist would caution all in their use of such a definition (or any definition for that matter) for control of the oil industry. Reasons for the caution are that: (i) the amount and reliability of the information needed to implement some M.E.R. rule effectively is far too costly to acquire; (ii) given the uncertainties any decision maker faces before taking action, then holding someone to the M.E.R. rule ex post action is unproductive and inefficient and trying to hold them to the rule ex ante action is infeasible. One might well ask what can be done to respond to the supposed oil problem. In any analysis of some situation or question one can remember to separate distinctly the following concerns: (i) The ofjective of obtaining the optimal (socially efficient) rates of production from fields. (ii) Recognition of genuine externalities, which cannot be internalized, i.e., cases where the market cannot be efficient. (iii) The political objective of maintenance and protection of oil producers' income and employment. (iv) The objective of meeting other political criteria. (v) The efficiency of political allocations. Political objectives will almost always dominate economic objectives, but at least we should distinguish the two and know the costs and benefits of both.

11213 Maximum efficient rate - a changing game. Bishop, K.A. pp 113-126 of Maximum efficient rate (MER) for petroleum reservoirs in the Outer Continental Shelf. Symposium proceedings. McFarland, J.W. (ed.). Houston, TX; University of Houston (1979).

From MER for petroleum reservoirs in the CCS symposium; Houston, TX, USA (29 Jan 1979).

The genealogy of MER and the history of oil production efficiency and conservation are described. Two ways of increasing domestic production of oil are in enhanced recovery from known reservoirs, and accelerated exploration particularly along the Outer Continental Shelf. Calculation of MER and optimization are next considered. (DLC)

PROCESSING

11214 (PB—291437) U.S. refining capacity: how much is enough. Report to the Congress. (General Accounting Office, Washington, DC (USA). Energy and Minerals Div.). 15 Jan 1979. 62p. NTIS, PC A04/MF A01.

From 83 to 92 percent of the Nation's petroleum products have been provided from U.S.-based refineries. Between now and 1985, the U.S. refining industry is planning capacity additions which should maintain this position. Whether or not refinery additions should take place will involve domestic and international trade-offs. This report discusses petroleum product demand, industry expansion plans, and Federal policies affecting those plans.

11215 Nonacidic multimetallic catalytic composite for use in hydrocarbon dehydrogenation. Antos, G.J.; Hayes, J.C.; Pollitzer, E.L. (to UOP Inc.). US Patent 4,167,496. 11 Sep 1979. Filed date 25 Aug 1978. 22p.

A nonacidic catalytic composite useful for dehydrogenating hydrocarbons comprises a combination of catalytically effective amounts of a platinum group component, a rhenium component, a cobalt component, a tin component and an alkali or alkaline earth component with a porous carrier material. A specific example of the nonacidic catalytic composite disclosed herein is a combination of a platinum group metal, rhenium, cobalt, tin and an alkali or alkaline earth metal with a porous carrier material in amounts sufficient to result in a composite containing, on an elemental basis, about 0.01 to about 2 wt % platinum group metal, about 0.01 to about 2 wt % rhenium, about 0.05 to about 5 wt % cobalt, about 0.01 to about 5 wt % tin and about 0.1 to about 5 wt % alkali metal or alkaline earth metal.

11216 Hydrocarbon treating process. Dick, J.E.; Sherk, F.T.; Drehman, L.E. (to Phillips Petroleum Co.). US Patent 4,167,472. 11 Sep 1979. Filed date 26 Apr 1978. 12p.

A process for treating a hydrocarbon composition containing both straight chain and non-straight chain hydrocarbons in which said hydrocarbon composition is separated into a straight chain hydrocarbon-rich fraction and a non-straight chain hydrocarbon-rich fraction, non-aromatics in said non-straight chain hydrocarbon rich fraction are converted to aromatics, and at least a portion of the straight chain hydrocarbon-rich fraction is passed in combination with steam over a steam active catalyst comprising at least one Group VII metal and a tin modified Group II metal aluminate under conditions such that aromatics are produced.

11217 Multiple-stage catalytic reforming with gravity-flowing dissimilar catalyst particles. Sikonia, J.G. (to UOP Inc.). US Patent 4,167,473. 11 Sep 1979. Filed date 2 May 1978. 14p.

A multiple-stage catalytic conversion system is described in which a hydrocarbonaceous charge stock and hydrogen flow serially through a plurality of catalytic reaction zones in each of which the catalyst particles are downwardly movable via gravity-flow. Dissimilar catalyst particles are utilized in the reactor systems, each of which is integrated with separate regenerating towers through which the catalyst particles are also downwardly movable via gravity-flow. Dissimilarity of the catalysts stems from a difference in activity and stability characteristics. In turn, this difference may be attributed either to physical, or chemical changes between the two composites, or a combination of both.

11218 Multiple-stage catalytic reforming with gravity-flowing dissimilar catalyst particles. Sikonia, J.G. (to UOP Inc.). US Patent 4,167,474. 11 Sep 1979. Filed date 2 May 1978. 14p.

A multiple-stage catalytic conversion system is described in which a hydrocarbonaceous charge stock and hydrogen flow serially through a plurality of catalytic reaction zones in each of which the catalyst particles are movable via gravity-flow. Dissimilar catalyst particles are utilized in the reactor systems which share a common regenerating tower through which the catalyst particles are also downwardly movable via gravity-flow. Dissimilarity of the catalyst particles stems from a difference in activity and stability characteristics. In turn, this difference may be attributed either to physical, or chemical changes between the two composites, or both.

11219 Process for purifying aromatic hydrocarbons. Nametkin, N.S.; Fedorov, V.V.; Feigin, E.A.; Kalinenko, R.A.; Cherny, I.R.; Bocharov, J.N.; Titov, V.B. US Patent 4,166,025. 28 Aug 1979. Priority date 22 Aug 1973, Union of Soviet Socialist Republics (USSR), 10p.

The invention describes processes for purifying aromatic hydrocarbons contained in liquid products of the refining of petroleum fractions or liquid products or liquid products of coal coking or low-temperature carbonization. The liquid products are heat-treated at temperatures ranging from 750° to 950°C under a pressure of 1 to 10 atm in the presence of acyclic C_2-C_4 hydrocarbons. These hydrocarbons are used separately in various combinations at a wt ratio of acyclic hydrocarbons/liquid products of at least 0.3. The heat treatment produces a vapor-gas mixture which is cooled to isolate the condensate containing predominantly aromatic hydrocarbons. The process is technologically simple and affords the possibility of purifying the aromatic hydrocarbons without decomposition.

11220 Refrigerative fractionation of cracking-gases in ethylene production plants. Gazzi, L.; Sguera, O. (to Snamprogetti S.p.A.). US Patent 4,163,652. 7 Aug 1979. Priority date 26 Mar 1976, Italy, 12p.

A process is described for the refrigerative fractionation of cracking-gases in an ethylene production plant. Ethane can be used as the refrigeration fluid thus allowing very low temperatures (down to minus 88°C) to be obtained: concurrently, the condensation with water is practicable whenever water is available in large masses at a temperature range from zero to 25°C, which is the case of seawater in cold countries or fresh waters in cold climate.

11221 Hydrocarbon conversion with an attenuated superactive multimetallic catalytic composite. Antos, G.J. (to UOP Inc.). US Patent 4,159,939. 3 Jul 1979. Filed date 26 May 1978. 28p.

Hydrocarbons are converted by contacting them at hydrocarbon conversion conditions with a novel attenuated superative multimetallic catalytic composite comprising a combination of a catalytically effective amount of a pyrolyzed rhenium carbonyl component with a porous carrier material containing a uniform dispersion of catalytically effective amounts of a platinum group component, which is maintained in the elemental metallic state, and of a tantalum component. In a highly preferred embodiment, this novel catalytic composite also contains a catalytically effective amount of a halogen component. The platinum group component, pyrolyzed rhenium carbonyl component, tantalum component and optional halogen component are preferably present in the multimetallic catalytic composite in amounts, calculated on an elemental basis, corresponding to about 0.01 to about 2 wt % platinum group metal, about 0.01 to about 5 wt % rhenium, about 0.01 to about 5% tantalum and about 0.1 to about 3.5 wt % halogen. A key feature associated with the preparation of the subject catalytic composite is reaction of a rhenium carbonyl complex with a porous carrier material containing a uniform dispersion of a tantalum component and of a platinum group metal maintained in the elemental state, whereby the interaction of the rhenium moiety with the platinum group moiety is maximized due to the platinophilic (i.e. platinum-seeking) propensities of the carbon monoxide ligand used in the rhenium reagent. A specific example of the type of hydrocarbon conversion process disclosed herein is a process for the catalytic reforming of a low octane gasoline fraction wherein the gasoline fraction and a hydrogen stream are contacted with the attenuated superactive multimetallic catalytic composite at reforming conditions.

11222 Conversion of hydrocarbons. Frilette, V.J.; Rubin, M.K. (to Mobil Oil Corp.). US Patent 4,157,950. 12 Jun 1979. Filed date 17 Oct 1977. 10p.

Crystalline aluminosilicate zeolites are used as catalysts for various hydrocarbon conversion processes and are particularly useful for conversion of paraffins in the presence of an alkylatable aromatic hydrocarbon such as benzene.

11223 People oriented program saves energy in a large petroleum refinery. Kanewkse, F.J. (Texaco Inc., Port Arthur, TX); Davidson, B.G. Jr. pp 74-79 of Fifty-eighth annual convention: meeting papers. Tulsa, OK; Gas Processors Association (1979).

From 58. annual convention of the Gas Processors Association; Denver, CO, USA (19 Mar 1979).

Energy in the form of fuel is a resource which must be actively conserved. The prime ingredient in any energy conservation effort is the people who participate in the program. This paper deals with successful methods used at Texaco Inc.'s Port Arthur, Tex. refinery to expand the awareness of refinery personnel of the need for energy conservation and to increase the ability to save energy in their day-to-day jobs. The end result is significant energy savings with minimum out-of-pocket investment.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 11228

11224 Lubricant composition containing a lubricity agent. Rowe, C.N. (to Mobil Oil Corp.). US Patent 4,167,486. 11 Sep 1979. Filed date 20 Jul 1978. 8p.

Lubricating oils containing olefin polymerizable acid esters and dimers and/or trimers thereof have been found to increase fuel economy in internal combustion engines. This is done by deposition of the additive on the lubricated surface.

11225 Polymer combinations useful in distillate hydrocarbon oils to improve cold flow properties. Wisotsky, M.J. (to Exxon Research and Engineering Co.). US Patent 4,153,423. 8 May 1979. Filed date 28 Mar 1975. 12p.

Oil soluble ethylene polymers or copolymers having a M/sub n/ greater than about 4000 in combination with an oil soluble polyester material such as a homopolymer or copolymer, comprising at least 10% by weight C_4 to C_{16} substantially straight-chain alkyl esters of acrylic or methacrylic acid, are useful in improving the cold flow properties of distillate hydrocarbon oils.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 12647, 12687

11226 (PB—290568) Control of volatile organic compound leaks from gasoline tank trucks and vapor collection systems. Shedd, S.A.; McLaughlin, N.D. (Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards). Dec 1978. 31p. NTIS, PC A03/MF A01.

This report provides the necessary guidance for development of regulations to limit emissions of volatile organic compounds (VOC) from gasoline tank trucks and vapor collection systems at bulk terminals, bulk plants and service stations. The intent of this guidance is to define leak tight conditions and related test procedures for vapor collection systems and tank trucks while loading and unloading gasoline at these facilities. The control approach described in this document is improved maintenance and would be enforced through the surveillance and periodic testing of leak points. This guidance includes a recommended regulation and testing procedures.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 11214, 11994, 12021, 12036, 12037, 12085

11227 (DOE/EIA—0096) Cost and indexes for oilfield equipment and production operations in the United States. (Department of Energy, Dallas, TX (USA). Energy Information Administration). Oct 1978. 81p. Dep. NTIS, PC A05/MF A01.

Oilfield equipment and/or operating costs for 1976 and 1977 on a hypothetical lease basis for selected depths in seven producing areas of the United States are presented. Indexes are included that measure change in industry costs for the period 1970 through 1977. These indexes measure the relative changes occurring in the costs of lease equipment and operating expenditures compared with the base year 1976. This study also provides the format for a systematic and consistent series of oilfield equipment and operating cost indexes, which may be published annually. Summary tables have been assimilated in the test and detailed tables of the costs and indexes for each category of equipment and operations utilized in the production of oil are presented in the appendixes. Onshore equipment costs increased from 91 to 170 percent depending upon area, depth, and type of lift during the period 1970 through 1977. Onshore annual operating costs increased from 97 to 155 percent during the period dependent upon area and type of operation considered and offshore operating costs increased about 105 percent.

11228 (DOE/EIA—0161/4Q(78)) DOE petroleum demand watch, October-December 1978. (Department of Energy, Washington, DC (USA). Office of Public Affairs). 1978. 29p. Dep. NTIS, PC A03/MF A01.

Weekly release provides trends in domestic demand for all petroleum products for previous four weeks and for same period in each of the previous two years and in 1973. Table details domestic demand and imports by barrels as well as in percentages. Data are given for the fourth quarter of 1978.

11229 (UT/CES-PS—7) Impact of Mexican oil on the world oil market. Creasey, J.D.; Langston, V.C. (Texas Univ., Austin (USA) Center for Energy Studies). Oct 1979. 188p. Dep. NTIS, PC A09/MF A01.

The impact of Mexico's new role as a major supplier of petroleum resources on OPEC and the world energy markets over the next 20 years are discussed. A review of six alternative world supply/demand forecasts is presented. Revenue projections for each member of OPEC are included. A modified Kennedy World Oil Model is used to analyze the changes that will result from Mexican entry into the world oil market. Policy implications for the 3 major participants in the market (the Persian Gulf, Mexico, and the United States) are analyzed. Also discussed is the stated intention of certain Persian Gulf suppliers to limit capacity expansion. The question of whether a barrel of oil is worth more in the ground than it is in today's market in regard to Mexican policy is discussed. Backstop research and development and conservation of oil usage in the USA are also covered. (DC)

11230 MER: three definitions. McDonald, S.L. (Univ. of Texas, Austin). pp 7-19 of Maximum efficient rate (MER) for petroleum reservoirs in the Outer Continental Shelf. Symposium proceedings. McFarland, J.W. (ed.). Houston, TX; University of Houston (1979).

From MER for petroleum reservoirs in the CCS symposium; Houston, TX, USA (29 Jan 1979).

The three definitions of MER (maximum efficient rate) are: the rate which maximizes ultimate recovery; the rate which maximizes ultimate recovery subject to a satisfactory overall rate of return; and the rate which maximizes the value of the reservoir.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 11239, 11240, 11241, 11242, 11409

11231 (PB—293315) Oil pollution reports. Volume 5, number 4. Quarterly report October 1978-December 1978. Ehrenspeck, H.; Sorenson, E.; Searles, B.; Osteryoung, K.; Roland, I. (California Univ., Santa Barbara (USA). Marine Science Inst.). Feb 1979. 203p. NTIS PC A10/MF A01.

OIL POLLUTION REPORTS (formerly OIL SPILL AND OIL POLLUTION REPORTS) is a quarterly compilation of abstracts of current oil pollution related literature, research projects, and conferences. Comprehensive coverage of terrestrial and aquatic oil pollution and its prevention and control is provided, with emphasis on the marine environment. The report contains (a) citations and summaries of 1976 to 1978 scientific and technical publications, and patents; (b) status and summaries of current research programs; and (c) information on current meetings.

11232 (PB—293433) Site selection guidelines for disposing of oil-saturated debris. Final report. Logan, A.; Fischer, R.M.; Malter, J. (Lake Champlain Basin Study, Burlington, VT (USA); Rutland Regional Planning Commission, VT (USA)). Aug 1978. 54p. NTIS PC A04/MF A01.

In the event an oil spill occurs on a body of water, debris is coated with oil. New York and Vermont, like most states, have plans for the removal of oil and debris from state lakes, rivers and streams. This report provides an analysis of alternatives for disposing oil-soaked debris. Those methods found to be most appropriate for the Lake Champlain Basin are landspreading, landfilling and burial. They are discussed at length in the report. Forty-six, Lake Champlain Basin sites, meeting the necessary criteria for oil-soaked debris disposal, were identified. A map and description of the areas are included in the work.

11233 (PNL-SA—7694) **Potential safety and environmental concerns in petroleum transportation.** Geffen, C.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1979. Contract EY-76-C-06-1830. 14p. (CONF-790778—1). Dep. NTIS, PC A02/MF A01.

From 1. international symposium on transportation safety; San Diego, CA, USA (11 Jul 1979).

This paper presents results of a study conducted for the Department of Energy by Pacific Northwest Laboratory to provide early recognition of and prioritize potential problems in petroleum transportation. Other objectives of this study are to identify possible gaps in the coverage of ongoing programs and recommend necessary action to mitigate th potential impact of identified problems. The remainder of this paper presents summaries of selected safety and environmental concerns in petroleum transportation. Each of these potential problems is discussed, together with recommendations for actions that address the problem. The concerns addressed in this paper deal with (1) gaps in oil spill prevention technology and practices, and (2) assessing the effects of oil spills that occur. The main topics covered are: the effects of marine oil pollution, oil spills trajectory modeling, environmental impact of pipeline leaks, cost-effective tanker safety design standards, training of waterway personnel, and insufficient Coast Guard manpower.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 12035

11234 **Maximum efficient rate (MER) for petroleum reservoirs in the Outer Continental Shelf. Symposium proceedings.** McFarland, J.W. (ed.). Houston, TX; University of Houston (1979). 172p. (CONF-790166—). Geological Survey, P.O. Box 25046, Federal Center, Denver, CO 80225.

From MER for petroleum reservoirs in the CCS symposium; Houston, TX, USA (29 Jan 1979).

The purpose of this symposium is to examine Federal regulations regarding maximum efficient rate and for oil and gas production from the Outer Continental Shelf of the US. A separate abstract was prepared for each of the nine papers included in the proceedings. (DLC)

11235 (PB—293952) **Georgia embayment - illustrating again the need for more data before selecting and leasing outer continental shelf lands.** (General Accounting Office, Washington, DC (USA). Energy and Minerals Div.). 19 Mar 1979. 27p. NTIS, PC A03/MF A01.

This report reviews the Department of the Interior's Southeast Georgia Embayment Outer Continental Shelf (OCS) Lease Sale 43. The leasing program's primary objectives are to promote the timely and orderly exploration and development of OCS lands, to help assure the public receives fair market value for those lands, and--in doing this--to protect the environment.

11236 **Is the MER a useful concept.** Cummings, R.G. pp 107-109 of Maximum efficient rate (MER) for petroleum reservoirs in the Outer Continental Shelf. Symposium proceedings. McFarland, J.W. (ed.). Houston, TX; University of Houston (1979).

From MER for petroleum reservoirs in the CCS symposium; Houston, TX, USA (29 Jan 1979).

The problem of defining the maximum efficient rate of production (MER) in PL 94-163 is considered. It is shown that a single rule for exploiting OCS petroleum reserves and satisfying multiple, conflicting criteria (profits and public weal) probably cannot be found. MER can be defined broadly as the private exploitation rate that results from operations within the rules imposed by the Dept. of the Interior. (DLC)

11237 **Thermodynamic approach to production regulation of oil and gas reservoirs.** Lohrenz, J.; Monash, E.A. pp 127-147 of Maximum efficient rate (MER) for petroleum reservoirs in the Outer Continental Shelf. Symposium proceedings. McFarland, J.W. (ed.). Houston, TX; University of Houston (1979).

From MER for petroleum reservoirs in the CCS symposium; Houston, TX, USA (29 Jan 1979).

The value one obtains from an oil and gas reservoir is obtained by making withdrawals from the reservoir. In the course of making those withdrawals, the exhaustive energy and the reservoir value are depleted. The laws of thermodynamics provide a measure of the exhaustive energy in a reservoir. The irreversible loss of every reservoir withdrawal is a decrease in the maximum available work of the reservoir. Therefore, an objective function to maximize for every withdrawal would be the ratio of the value obtained by the withdrawal to the maximum available work decrease because of the withdrawal. A reservoir is, then, properly operated when this ratio is maximized given the value is assessed properly. The purview of production regulation policy-making is to make unambivalent rules regarding how the value in that objective function may and may not be computed. Within, first, any constraints of production regulations which are subject to policy-makers' value algorithms and, second, the inviolate laws of thermodynamics, the domain of reservoir operators is to get as much value as possible from a withdrawal per irreversible expenditure of exhaustive energy in the reservoir.

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 11175, 11181, 11233

11238 (AD-A—068311) **Pressure rise in a vented cargo tank due to external heating. Final report.** Wilson, R.P. Jr; Raj, P.K.P. (Little (Arthur D.), Inc., Cambridge, MA (USA)). Apr 1976. Contract DOT-CG-42-357-A. 80p. NTIS, PC A05/MF A01.

The normal venting capacity of marine cargo tanks appears to be adequate for relieving vapor generated when integral tanks are exposed to an external fire. However, the unwetted tank walls surrounding the ullage are subject to substantial weakening in those cases where the fire heat flux increases the wall temperature above 1000 deg. F. Convection and radiation can adequately cool the unwetted wall only for incident heat flux less than 16,000 BTU/hr/ft2. Thus, the failure mode of cargo tanks with an external fire may be due not to the vent system, but rather to heating of the unwetted wall.

11239 (DOE/TIC—11091(Vol.1)) **Final environmental statement: crude oil transportation systems. (Proposed under Public Law 95-617, the Public Utility Regulatory Policies Act of 1978).** (Bureau of Land Management, Washington, DC (USA)). 1979. 770p. Dep. NTIS, PC A99/MF A01.

Volume 1 contains a description of each of the four Title V proposals and a description and analysis of the proposed Northern Tier Pipeline Company System. This company proposes port and onshore storage facilities at Port Angeles, Washington, and a 1,491-mile pipeline system extending to Clearbrook, Minnesota. Throughput capacities would be 709,000 barrels per day initially and 933,000 barrels per day ultimately. The system would be designed to supply an additional 350,000 barrels per day to existing refineries in the Puget Sound Area.

11240 (DOE/TIC—11091(Vol.2)) **Final environmental statement: crude oil transportation systems.** (Bureau of Land Management, Washington, DC (USA)). 1979. 538p. Dep. NTIS, PC A23/MF A01.

Volume 2 contains a description and analysis of the other three proposed systems. A summary of the Title V proposals is presented. Northwest Energy Company proposes port and onshore storage facilities at Skagway, Alaska, and a 710-mile pipeline system extending to Keg River, Alberta. The first 14 miles of the pipeline would be in Alaska, with the remaining 696 miles in Canada. Throughput capacities would be 530,000 barrels per day initially and 750,000 barrels per day ultimately. From Keg River, crude oil would be delivered through existing systems to the northern tier states. Kitimat Pipe Line Ltd. proposes port and onshore storage facilities at Kitimat, British Columbia, and a 753-mile pipeline extending to Edmonton, Alberta. Throughput capacities would be 450,000 barrels per day initially and 900,000 barrels per day ultimately. From Edmonton, crude oil would be delivered through existing systems to the northern tier states. Trans Mountain Oil Pipe Line Corporation proposes port and onshore storage facilities at Low Point near Port Angeles, Washington, and an 823-mile pipeline system extending to Edmonton, Alberta. The first 148 miles of the pipeline system would be in Washington with the remaining 675 miles in Canada. Throughput capacities would be 500,000 barrels per day initially and 630,000 barrels per day ultimately. From Edmonton, crude oil would be delivered through existing systems to northern tier states.

11241 (DOE/TIC—11091(Vol.3)) **Final environmental statement: crude oil transportation systems.** (Bureau of Land Management, Washington, DC (USA)). 1979. 977p. Dep. NTIS, PC A99/MF A01.

Volume 3 contains alternatives to each of the four systems and public comment on the draft Environmental Statement. Environmental statement team responses are included.

11242 (DOE/TIC—11091(Vol.4)) **Final environmental statement: crude oil transportation systems. Map addendum.** (Bureau of Land Management, Washington, DC (USA)). 1979. 634p. Dep. NTIS, PC A99/MF A01.

Volume 4 contains maps relating to each of the four proposals.

11243 (NTIS/PS—79/0496) **Pipeline corrosion (citations from the NTIS data base). Report for 1964-April 1979.** Reed, W.E. (National Technical Information Service, Springfield, VA (USA)). May 1979. 151p. NTIS PCN01/MF N01.

Federally-sponsored research on pipeline corrosion in soils, sea water, and fresh water are covered. Studies include pipeline systems containing natural gas, petroleum, slurries, water, and vola-

tile or corrosive liquids. Materials for pipelines are discussed as well as inhibitors for pipeline systems. Coatings, linings, welding, and testing are described as they relate to corrosion. (This updated bibliography contains 145 abstracts, 11 of which are new entries to the previous edition.)

11244 (PB—292978) **Radio frequency liquid level gauging in propane tank car safety tests - a feasibility study.** Siegwarth, J.D. (National Bureau of Standards, Boulder, CO (USA). Thermophysical Properties Div.). Jan 1979. 15p. NTIS PC A02/MF A01.

Selected radio frequency (rf) resonances of an empty 30,300 liter (8,000 gallon) tank car have been measured to determine whether rf can be used to gauge the propane liquid levels during tank car fire safety tests. The change of resonant frequencies of a small horizontal cylindrical tank as a function of liquid volume has been tested in order to estimate the precision to which the amount of propane in a tank car can be measured. The technique is applicable to routine tank car gauging.

11245 (PB—293536) **Survey of gasoline tank trucks and rail cars.** Hang, J.C.; Sakaida, R.R. (Pacific Environmental Services, Inc., Santa Monica, CA (USA)). Mar 1979. Contract EPA-68-02-2606. 48p. NTIS, PC A03/MF A01.

This informational document provides the basic and current use of tank trucks and rail cars in the gasoline marketing industry. Information contained in this document includes population, type and age of equipment, industry trends and costs for retrofitting existing vehicles to bottom loading and/or vapor recovery.

PROPERTIES

REFER ALSO TO CITATION(S) 11119

11246 (BETC/PPS—79/5) **Diesel fuel oils, 1979.** Shelton, E.M. (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). Dec 1979. 38p. Dep. NTIS, PC A03/MF A01.

Properties of diesel fuels produced during 1979 were submitted for study and compilation under a cooperative agreement between the Department of Energy (DOE), Bartlesville Energy Technology Center (BETC), Bartlesville, Oklahoma and the American Petroleum Institute (API). Tests of 200 samples of diesel fuel oils from 94 refineries throughout the country were made by 29 petroleum refining companies. The analyses of the fuels are listed in tables for four groups according to type of diesel fuel. Each group of analyses is subdivided into five tabulations according to five general regions of the country where the fuels are marketed. The regions, containing a total of 16 districts, are shown on a map in the report. Data from 13 laboratory tests on each individual diesel fuel sample are listed and arranged by geographic marketing districts in decreasing order of sales volumes. Charts are included showing trends of averages of certain properties for the four types of diesel fuels for the years 1960-1979. Summaries of the results of the 1979 survey, compared with similar data for 1978, are shown in tables 1 through 4 of the report.

11247 Characterization parameters for hydrocarbons for physical and thermodynamic property prediction. Daubert, T.E. (Pennsylvania State Univ., University Park). pp 17-24 of Fifty-eighth annual convention: meeting papers. Tulsa, OK; Gas Processors Association (1979).

From 58. annual convention of the Gas Processors Association; Denver, CO, USA (19 Mar 1979).

Over the past several years the group compiling the Technical Data Book - Petroleum Refining for the American Petroleum Institute has been reexamining, reevaluating, and improving methods for the characterization of petroleum fractions as inputs to correlations for predicting physical, thermodynamic, and transport properties of undefined mixtures. This paper is a state-of-the-art report on the methods available for estimation of basic parameters and their use in predicting properties and covers both traditional methods used over the past 40 years as well as recent developments. Traditional and new methods for prediction of the basic parameters of molecular weight, acentric factor and pseudocritical temperature and pressure, and molecular type analysis are reviewed and evaluated. Their use in prediction of thermodynamic properties typified by enthalpy and transport properties such as viscosity follow. An evaluation of the state-of-the-art is presented indicating the types of correlational work and experimental data necessary for resolution of some of the remaining problems in prediction.

STORAGE

REFER ALSO TO CITATION(S) 11972

11248 (PB—290579) **Control of volatile organic emissions from petroleum liquid storage in external floating roof tanks.** Burr, R.K.; Brothers, K.C.; Wright, J.G. (Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards). Dec 1978. 64p. NTIS, PC A04/MF A01.

This report provides the necessary guidance for development of regulations limiting emissions of volatile organic compounds (VOC) from storage of petroleum liquids in external floating roof tanks. Reasonably available control technology (RACT) is defined in this document; cost analysis for RACT is included for evaluating the cost effectiveness of controlling external floating roof tank sources.

11249 Method and apparatus for preventing agglomeration within fluid hydrocarbons. Woodbridge, D.D. US Patent 4,172,019. 23 Oct 1979. Filed date 23 Nov 1977. 10p.

This invention relates to a process for treating a fluid hydrocarbon fuel for retarding the agglomeration between particles thereof and for retarding the growth of bacteria and fungi therein. The process includes that steps of transporting a plurality of unit volumes of said fluid hydrocarbon fuel through an irradiating location and irradiating each unit of the plurality of unit volumes at the irradiating location with either neutron or gamma radiation. An apparatus for treating the fluid hydrocarbon fuels with the nuclear radiation also is provided. The apparatus includes a generally conical central irradiating cavity which is surrounded by a spiral outer irradiating cavity. The fluid hydrocarbon fuel is transported through the cavities while being irradiated by the nuclear radiation.

COMBUSTION

REFER ALSO TO CITATION(S) 11174, 11194, 11196, 12268

11250 (N—79-20261) **Experimental investigation of fuel evaporation in the vaporizing elements of combustion chambers.** Vezhba, I. Translated from *Arch. Procesow Spalania;* **1**: No. 2, 179-190(Feb 1979). 18p. NTIS, PC A02/MF A01.

A description is given of the experimental apparatus and the methods used in the investigation of the degree of fuel (kerosene) evaporation in two types of vaporizing elements in combustion chambers. The results are presented as dependences of the degree of fuel evaporation on the factors which characterize the functioning of the vaporizing elements: the air surplus coefficient, the velocity of flow and temperature of the air at the entrance to the vaporizing element and the temperature of the wall of the vaporizing element.

NATURAL GAS

11251 (LIB-tr—4692) **A few world natural gas statistics for 1977. (Reserves, production, imports, exports, consumption, and contracts signed from 1/1/1977 to 1/7/1978).** 1978. Translation source information not available. 23p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Portions of document are illegible.

The statistics given and discussed include: world proven natural gas reserves at 1/1/1978; gross production in the world in 1977; marketed production in the world in 1977; and consumption, imports, and exports of natural gas in the world in 1977. Individual regions of the world are discussed. (Tables are not reproduced.) (DLC)

GEOLOGY AND EXPLORATION

11252 (DOE/BC/10018—T2) **Remote characterization of fluid saturation in Western sands.** Nuckols, E.B.; Jackson, J. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract AT19-79BC10018. 8p. Dep. NTIS, PC A02/MF A01.

Purpose is to develop methods to define fluid saturation, porosity, and permeability in Western Gas Sands as a function of in situ stress conditions. These analyses will then be correlated with Nuclear Magnetic Resonance studies that ultimately lead to the design of an improved downhole Nuclear Magnetic Resonance Tool.

11253 (DOE/MC/05205—T6) **Characterization and analysis of Devonian shales as related to release of gaseous hydrocarbons: Well A-1 McKean County, Pennsylvania.** Kalyoncu, R.S.; Boyer, J.P.; Snyder, M.J. (Battelle Columbus Labs., OH (USA)). Dec 1979. Contract AC21-76MC05205. 90p. Dep. NTIS, PC A05/MF A01.

Shale samples from Allegany County, Pennsylvania (A-2) were analyzed and characterized with the objective of determining the relationships between the gas contents and shale characteristics.

A total of 73 core samples were taken from this well (24 for Battelle and 49 for other DOE contractors). The A-2 well is characterized by its wide range of carbon (1.4 to 14.8%) and sulfur contents (0.2 to 8.0%). Mean value of hydrocarbon gas contents in these shales was found to be 0 to 30 v/v, with 0.24 and 0.35 lower and upper limits, respectively. No discernable relationship is found in the gas contents with shale depth. A-2 shales also appear to have very high surface areas (mean value of 9.22 m^2/g) with bulk densities comparable to those from other locations. Helium permeabilities of samples measured were higher than those from other locations. Lithology of these shales did not differ greatly from shales of other locations.

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 11146, 11147, 11148, 11149, 11150, 11151, 11152, 11153, 11154, 11155, 11156, 11157, 11158, 11159, 11160, 11161, 11162, 11210, 11211, 11212, 11213, 11285, 12285

11254 (PB—290499) **Opportunities for increasing natural gas production in the near term. Volume 1. The Tiger Shoal Field. Final report.** (National Research Council, Washington, DC (USA). Committee on Gas Production Opportunities). Oct 1977. Contract DI-14-01-0001-77-C-28. 113p. NTIS, PC A06/MF A01.

This report examines the potential for increasing the rate of production of natural gas from the Tiger Shoal Field in the Gulf of Mexico Outer Continental Shelf. Proved reserves are estimated using all available reservoir data, including well logs and pressure tests, and cost parameters typical in the area. Alternative schedules for future production are devised and net present values are estimated from which the maximum production rate that also maximizes net present value is determined.

11255 (PB—290501) **Opportunities for increasing natural gas production in the near term. Volume III. Eugene Island Block 266 Unit. Final report.** (National Research Council, Washington, DC (USA). Committee on Gas Production Opportunities). Dec 1977. Contract DI-14-01-0001-77-C-28. 91p. NTIS, PC A05/MF A01.

This report examines the potential for increasing the rate of production of natural gas from the Eugene Island Block 266 Unit in the Gulf of Mexico Outer Continental Shelf. Proved reserves are estimated using all available reservoir data, including well logs and pressure tests, and cost parameters typical in the area. Alternative schedules for future production are devised and net present values calculated from which the maximum production rate that also maximizes net present value is determined.

11256 (PB—290502) **Opportunities for increasing natural gas production in the near term. Volume IV. The Vermilion Block 14 Unit. Final report.** (National Research Council, Washington, DC (USA). Committee on Gas Production Opportunities). Jan 1978. Contract DI-14-01-0001-77-C-28. 115p. NTIS, PC A06/MF A01.

This report examines the potential for increasing the rate of production of natural gas from the Vermilion Block 14 Unit in the Gulf of Mexico Outer Continental Shelf. Proved reserves are estimated using all available reservoir data, including well logs and pressure tests, and cost parameters typical in the area. Alternative schedules for future production are devised and net present values calculated from which the maximum production rate that also maximizes net present value is determined.

11257 (PB—290503) **Opportunities for increasing natural gas production in the near term. Volume V. The South Marsh Island Block 48 Field. Final report.** (National Research Council, Washington, DC (USA). Committee on Gas Production Opportunities). Jan 1978. Contract DI-14-01-0001-77-C-28. 120p. NTIS, PC A06/MF A01.

This report examines the potential for increasing the rate of production of natural gas from the South Marsh Island Block 48 Field in the Gulf of Mexico Outer Continental Shelf. Proved reserves are estimated using all available reservoir data, including well logs and pressure tests, and cost parameters typical in the area. Alternative schedules for future production are devised and net present values calculated from which the maximum production rate that also maximizes net present value is determined.

11258 (PB—290504) **Opportunities for increasing natural gas production in the near term. Volume VI. The East Cameron Block 271 Field. Final report.** (National Research Council, Washington, DC (USA). Committee on Gas Production Opportunities). Feb 1978. Contract DI-14-01-0001-77-C-28. 120p. NTIS, PC A06/MF A01.

This report examines the potential for increasing the rate of production of natural gas from the East Cameron Block 271 Field in the Gulf of Mexico Outer Continental Shelf. Proved reserves are estimated using all available reservoir data, including well logs and pressure tests, and cost parameters typical in the area. Alternative schedules for future production are devised, and net present values calculated from which the maximum production rate that also maximizes net present value is determined.

11259 **Hydrocarbon gas processing.** Campbell, R.E.; Wilkinson, J.D.; Rambo, C.L. (to Ortloff Corp.). US Patent 4,171,964. 23 Oct 1979. Filed date 4 Oct 1976. 28p.

The processing of gas streams containing hydrocarbons and other gases of similar volatility to recover high yields of components such as ethane, propane, and heavier hydrocarbons therefrom by cooling the gas stream under pressure to form a liquid portion, and expanding the liquid portion to a pressure lower than feed pressure whereby a part of the liquid portion vaporizes to cool the remaining part of the liquid portion is improved by pre-cooling the liquid portion prior to flash expansion. In one embodiment this is accomplished by dividing the remaining part of the liquid portion into a first and second stream, directing the first liquid stream into heat exchange relation with the liquid portion of the feed stream prior to expansion to warm the first liquid stream and pre-cool the liquid portion prior to expansion. Both first and second liquid streams are then supplied to a fractionating column, the second stream being supplied to the fractionating column at a point thereon higher than the first stream. Several other methods of pre-cooling the liquid portion are also described.

11260 **Effect of rate of production of a natural gas well on the deliverable maximum work.** Sliepcevich, C.M. pp 110-112 of Maximum efficient rate (MER) for petroleum reservoirs in the Outer Continental Shelf. Symposium proceedings. McFarland, J.W. (ed.). Houston, TX; University of Houston (1979).

From MER for petroleum reservoirs in the CCS symposium; Houston, TX, USA (29 Jan 1979).

Based on the maximum work principle or the availability of energy, it appears that the most plausible working definition of maximum efficient recovery (MER) is that rate of production which assures the maximum ultimate recovery consistent with an acceptable rate of financial return to the producer.

11261 **Real natural gas reservoir data vs natural gas reservoir models.** Monash, E.A.; Lohrenz, J. pp 148-169 of Maximum efficient rate (MER) for petroleum reservoirs in the Outer Continental Shelf. Symposium proceedings. McFarland, J.W. (ed.). Houston, TX; University of Houston (1979).

From MER for petroleum reservoirs in the CCS symposium; Houston, TX, USA (29 Jan 1979).

The gas reservoir per se model is an exceedingly simple model of a natural gas reservoir designed to develop the physical relationship between ultimate recovery and rate(s) of withdrawal for production regulation policy assessment. To be responsive, the model must be able to consider rates of withdrawal both far lower and higher than current practices which are dependent on current policies. For this model, as for every model, a reasonable question arises, "Does the model actually work as supposed". What makes this question of great concern is that one cannot resort to replicated experiments in either real or model reservoirs to check a gas reservoir model. One can, however, challenge the model with real gas reservoir data. This is what we did and found that this exceedingly simple model fits real gas reservoir data in a very satisfying manner. 5 figures, 3 tables.

11262 **Fifty-eighth annual convention: meeting papers.** Tulsa, OK; Gas Processors Association (1979). 168p. (CONF-790390—).

From 58. annual convention of the Gas Processors Association; Denver, CO, USA (19 Mar 1979).

Sessions were held on energy in the eighties, efficient utilization of energy, international gas processing facility construction, international natural gas liquids supply and markets, product treating, and plant site considerations. Selected papers were indexed separately.

11263 **Economics of saving energy in gas plant design.** Moncrief, C.R. (Ortloff Corp., Midland, TX). pp 61-66 of Fifty-eighth annual convention: meeting papers. Tulsa, OK; Gas Processors Association (1979).

From 58. annual convention of the Gas Processors Association; Denver, CO, USA (19 Mar 1979).

Areas in plant design are outlined where higher gas prices could warrant analysis to determine the economic feasibility of energy conservation schemes. The cost figures presented were developed for the Southern Sunbelt area of the United States for new, onshore, gas processing facilities. Before-tax payout was used for comparison of the various schemes for conserving energy. Fuel gas prices are states in each analysis. Electric power was assumed to cost $0.025/kwh in all cases. The types of facilities on which the economic studies were made include cryogenic NGL recovery plants with fractionation, gas treating plants with associated sulfur recovery systems, condensate stabilization plants, and sour crude production facilities.

11264 **Improving energy efficiency of processing plants with computers and instrumentation.** Hachmuth, H.K.; Griffin, D.E. (Applied Automation, Inc., Bartlesville, OK). pp 68-70 of Fifty-eighth annual

convention: meeting papers. Tulsa, OK; Gas Processors Association (1979).

From 58. annual convention of the Gas Processors Association; Denver, CO, USA (19 Mar 1979).

The following topics are discussed: Btu measurement by chromatography; energy saving controls for expander plants; energy saving controls for fractionators; and energy saving controls for gas treating.

11265 Efficient utilization of energy in gas processing plants: an overview. Knowles, W.T. (Shell Oil Co., Houston, TX). pp 71-73 of Fifty-eighth annual convention: meeting papers. Tulsa, OK; Gas Processors Association (1979).

From 58. annual convention of the Gas Processors Association; Denver, CO, USA (19 Mar 1979).

This paper addresses the impact of rising energy costs on plant expenses, outlines steps which can be taken to identify those plants and energy consuming operations with the greatest potential for conservation and provides some leads as to specific actions which should be considered.

11266 Current natural gas liquid treating methods in Canada. Masson, W.B. (Dome Petroleum Ltd., Calgary, Alberta); Davidson, K.B. pp 127-134 of Fifty-eighth annual convention: meeting papers. Tulsa, OK; Gas Processors Association (1979).

From 58. annual convention of the Gas Processors Association; Denver, CO, USA (19 Mar 1979).

Processes involving amines, caustics, and molecular sieves for sulfur removal and molecular sieves and desiccants for water removal, are the ones most commonly used in the treatment of propane and butane in the Canadian Gas Processing Industry. Careful analysis of the plant process and identification of the sulfur compounds to be removed is required in order that a proper economical treatment process or combination of processes can be selected which will result in specification product.

11267 MALAPROP: an amine process for removal of COS from propane. Morrow, D.C.; McClure, G.P. (Mallard Exploration, Inc., Midland, TX). pp 135-147 of Fifty-eighth annual convention: meeting papers. Tulsa, OK; Gas Processors Association (1979).

From 58. annual convention of the Gas Processors Association; Denver, CO, USA (19 Mar 1979).

MALAPROP is a single-step process that uses diglycolamine for removal of COS from very high levels (>4000 ppM) to less than 2 ppM in propane. Advantages of this process are: low chemical consumption; low fuel consumption; coincidental removal of H_2S and CO_2; offers basic simplicity of an amine system; and ability to stand large variations in inlet COS content and still maintain finished product specifications. This process has been in commercial operation in the Mallard Big Escambia Creek plant for 2 years during which time considerable design evolution has occurred.

PRODUCTS AND BY-PRODUCTS

11268 (DOE/EIA—0132/6-8(78)) **Products of natural gas processing plants, June-August 1978.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 1978. 6p. Dep. NTIS, PC A02/MF A01.

Production figures and end-of-month stocks for products at natural gas processing plants in the United States are provided. Data for the production of ethane, liquified petroleum gases, isopentane, natural gasoline, plant condensate, and total finished products are reported for the most recent month, the prior month, the corresponding month in the previous year, and the calendar year-to-date of the current and past year. End-of-month stocks at the plants, including those held in underground storage, are listed for the current month and the same month of the preceding year. Preliminary figures for the following month are provided for production of propane and for all products of natural gas processing plants. June, July, and August 1978 data are given.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 12687

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 11230

11269 (DOE/EIA—0166) **Reduction in natural gas requirements due to fuel switching, April 1973-March 1978.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Jan 1979. 16p. Dep. NTIS, PC A02/MF A01.

Results of a mandatory survey directed to natural gas companies known to sell natural gas directly to end-use consumers are presented. The purpose of the survey was to determine the number, size range, category, and location of natural gas consumers who permanently switched to another fuel for all or part of their energy needs during each of the five heating years between 1973 to 1978. Reductions in annual natural gas requirements due to fuel switching were reported by respondents in aggregate form by heating year (April 1-March 31) in which the customer switched, by State and the District of Columbia, and by DOE regions in which service was rendered, by customer categories (industrial, commercial, or electric utility), further delineated by customer size range (large = 100 million cubic feet or more annual requirements, and small = under 100 million cubic feet annual requirements), and by types of alternative fuel chosen (residual fuel oil, middle distillates, electricity, coal, propane/butane, and other). Fuel switching by residential customers was not included. The results of the survey are discussed in a narrative section. 6 tables.

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 11209

11270 (UCRL—83419) **Hydraulic fracturing near interfaces.** Shaffer, R.J.; Hanson, M.E.; Anderson, G.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1979. Contract W-7405-ENG-48. 33p. (CONF-800204—4). Dep. NTIS, PC A03/MF A01.

From Energy-sources technology conference; New Orleans, LA, USA (3 Feb 1980).

Theoretical and experimental studies are being conducted of pressure driven fractures near interfaces that separate differing materials. When a crack propagates in material A toward a well bonded interface at half the dilatational wave speed, there is an amplification in the likelihood of crack penetration into material B. This amplification increases as material A becomes stiffer relative to B. The stress intensity factor of the leading crack tip decreases as the crack approaches a stiffer material and increases as the crack approaches a more flexible material. Additionally, when existing cracks are present near the interface, the effects of the change in material properties are reduced. In equilibrium analyses with unbonded interfaces, where shear stresses are transmitted via friction, a decrease in the coefficient of friction reduces the likelihood of crack penetration into the adjacent material when both materials are identical; however, decreasing friction tends to draw the crack toward the interface. Friction coefficients and hydrofracture penetration characteristics were measured in Indiana limestone and Nugget sandstone. There is a least stress required across the interface for a hydrofracture to cross the interface; this stress depends on rock type, interface surface finish, and water content.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 11234, 11236, 11237, 12035, 12038, 12039

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 11175, 11238, 11243, 11408

PROPERTIES

REFER ALSO TO CITATION(S) 11247

11271 Density of liquefied natural gas. Haynes, W.M.; McCarty, R.D. (National Bureau of Standards, Boulder, CO). pp 10-16 of Fifty-eighth annual convention: meeting papers. Tulsa, OK; Gas Processors Association (1979).

From 58. annual convention of the Gas Processors Association; Denver, CO, USA (19 Mar 1979).

A project has been carried out at the National Bureau of Standards to provide a means for the accurate determination of the density of liquefied natural gas (LNG) that would serve as a basis for equitable custody transfer of this valuable commodity. A magnetic suspension densimeter was used to obtain a consistent set of density data for LNG components and their mixtures with a total uncertainty in density of less than 0.1%. These data were used to optimize and test mathematical models for LNG density calculations. A description of the apparatus, data, uncertainties, experimental procedures, etc., is presented. Three mathematical models for the calculation of LNG densities have been optimized, tested, and compared. These

models are an extended corresponding states model, a hard sphere model, and an empirical model due to Klosek and McKinley. It is believed that the final objective of this project, which was to produce one or more mathematical models that could be used to predict the density of a given LNG within 0.1% of its true value from an input of pressure, temperature, and composition, has been achieved.

11272 Improved measurements and correlation of the water content of methane gas in equilibrium with hydrate. Aoyagi, K. (Photovolt Corp., New York, NY); Song, K.Y.; Sloan, E.D.; Dharmawardhana, P.B.; Kobayashi, R. pp 25-28 of Fifty-eighth annual convention: meeting papers. Tulsa, OK; Gas Processors Association (1979).

From 58. annual convention of the Gas Processors Association; Denver, CO, USA (19 Mar 1979).

Experimental measurements of water content in methane gas in equilibrium with hydrate are reported at 500, 1000 and 1500 psia for the temperatures ranging from 234 to 270K. The water concentrations measured in the current investigation show much lower values than those taken at lower temperatures or extrapolated to lower temperature regions for natural gas. These findings suggest that the water content in methane gas should be kept to lower levels than in prevailing practices, to avoid the hydrate formation in gas processes. The smoothed experimental data are compared with predictions made theoretically at the intervals of 10°C using the virial equation of state with the water content data to extract the principal cross virial coefficients (cross second virial coefficients for water-methane, and third virial coefficients for water-methane-methane).

11273 Classical and conventional methods of LPG sulfur analysis. Russo, S. (Southern Petroleum Labs., Inc., Houston, TX). pp 124-126 of Fifty-eighth annual convention: meeting papers. Tulsa, OK; Gas Processors Association (1979).

From 58. annual convention of the Gas Processors Association; Denver, CO, USA (19 Mar 1979).

Methods of detection and analysis of hydrogen sulfide, carbonyl sulfide, carbon disulfide, sulfur dioxide, and the mercaptans are discussed. Two chemical tests have found industry acceptance as being quantitative methods for the determination of H_2S and mercaptans: the Tutweiler method and cadmium sulfate-iodometric titration. Other sulfur compounds can be determined by using a number of chemical techniques. Barton titrations have been used for sulfur determinations and total sulfurs are generally determined in the laboratory using methods which involve the oxidation of the sulfur compounds to sulfur dioxide and a subsequent chemical or electrochemical titration. The use of the flame photometric detector to identify and quantitate sulfur compounds is discussed.

STORAGE

REFER ALSO TO CITATION(S) 11972, 12176

OIL SHALES AND TAR SANDS

RESERVES AND EXPLORATION

11274 (DOE/TIC—10251) **Colorado oil shale: the current status, October 1979.** (Colorado Dept. of Natural Resources, Denver (USA)). 1979. Contract FG48-79R800212. 138p. Dep. NTIS, PC A07/MF A01.

A general background to oil shale and the potential impacts of its development is given. A map containing the names and locations of current oil shale holdings is included. The history, geography, archaeology, ecology, water resources, air quality, energy resources, land use, sociology, transportation, and electric power for the state of Colorado are discussed. The Colorado Joint Review Process Stages I, II, and III-oil shale are explained. Projected shale oil production capacity to 1990 is presented. (DC)

SITE GEOLOGY AND HYDROLOGY

SITE GEOLOGY

REFER ALSO TO CITATION(S) 11204, 11253

11275 (ORO—5203-3(80)) **Geologic and geochemical studies of the New Albany Group (Devonian black shale) in Illinois to evaluate its characteristics as a source of hydrocarbons. Quarterly progress report, October 1-December 31, 1979.** Bergstrom, R.E.; Shimp, N.F. (Illinois State Geological Survey, Urbana (USA)). 7 Jan 1980. Contract EY-76-C-05-5203. 38p. Dep. NTIS, PC A03/MF A01.

This project is a detailed analysis of the lithology, stratigraphy, and structure of the New Albany Group in Illinois to determine those characteristics of lithology, thickness, regional distribution, vertical and lateral variability, and deformation that are most relevant to the occurrence of hydrocarbons. Research is reported for this quarter in the following areas: coordination of stratigraphic maps, mineralogic and petrographic characterization, physical properties of Devonian black shale, quantitative determination of major, minor, and trace elements in shales, inorganic/organic associations of trace elements in black shales, mode of occurrence and relative distribution of hydrocarbon phases in shale, and adsorption/desorption studies of gases through shales. 6 figures, 7 tables. (RWR)

SITE HYDROLOGY

11276 (LETC—0013-1) **Water availability for development of major tar sands areas in Utah.** Keefer, T.N.; McQuivey, R.S. (Sutron Corp., Arlington, VA (USA)). May 1979. Contract EW-78-S-20-0013. 252p. Dep. NTIS, PC A12/MF A01.

The Sutron Corporation, under contract with Colorado State University, has conducted a study for the Laramie Energy Technology Center (LETC) to determine the availability of water for future extraction of viscous petroleum (bitumen) from the six major tar sands deposits in Utah. Specifically, the areas are: Asphalt Ridge and Whiterocks, which lie immediately west of Vernal, Utah; P.R. Spring, a large area extending from the Colorado River to the White River along Utah's eastern border; Hill Creek, adjacent to P.R. Spring to the west; Sunnyside, immediately across the Green River from Hill Creek between the Price and Green Rivers; and Tar Sand Triangle, near the confluence of the Colorado and Dirty Devil Rivers. The study, conducted between September and December of 1978, was a fact-finding effort involving the compilation of information from publications of the US Geological Survey (USGS), Utah State Engineer, Utah Department of Natural Resources, and other federal and state agencies. The information covers the general physiographic and geologic features of the total area, the estimated water requirements for tar sands development, the availability of water in each of the six areas, and the legal and sociological restraints and impacts. The conclusions regarding water availability for tar sands development in each of the six areas and specific recommendations related to the development of each area are presented also.

DRILLING, FRACTURING, AND MINING

REFER ALSO TO CITATION(S) 11173, 11279, 11286

11277 (LA—7813-PR) **Explosively produced fracture of oil shale. Progress report, July-September 1978.** Schmidt, S.C. (comp.). (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 24p. Dep. NTIS, PC A02/MF A01.

A generalized constitutive stress-strain relation that accounts for crack growth is presented. The effects of both tensile and shear stresses on crack strain are included. Macroscopic properties are determined by averaging over a crack distribution function. A bedded crack version of the fracture model has been incorporated into the YAQUI hydrodynamics code. Test calculations of free-surface spall with and without fracture show a distinct difference in the behavior of the reflected tension wave. Performance properties of the commercial explosive TAL-1005 E have been calculated from experimental data. Results of identical tests for nitromethane are also shown. Crater blast data for both laboratory- and field-size experiments are given. Results are interpreted using published empirical cratering and fragmentation techniques.

11278 (LA-UR—79-3110) **Permeability enhancement using explosive techniques.** Adams, T.F.; Schmidt, S.C.; Carter, W.J. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 12p. (CONF-800204—3). Dep. NTIS, PC A02/MF A01.

From Energy-sources technology conference; New Orleans, LA, USA (3 Feb 1980).

In situ recovery methods for many of our hydrocarbon and mineral resources depend on the ability to create or enhance permeability in the resource bed to allow uniform and predictable flow. To meet this need, a new branch of geomechanics devoted to computer prediction of explosive rock breakage and permeability enhancement has developed. The computer is used to solve the nonlinear equations of compressible flow, with the explosive behavior and constitutive properties of the medium providing the initial/boundary conditions and material response. Once the resulting computational tool has been verified and calibrated with appropriate large-scale field tests, it can be used to develop and optimize commercially useful explosive techniques for in situ resource recovery.

OIL PRODUCTION, RECOVERY, AND REFINING

REFER ALSO TO CITATION(S) 11207, 11215, 11216, 11217, 11218

11279 (PB—293279) **Compendium reports on oil shale technology.** Slawson, G.C. Jr; Yen, T.F. (General Electric Co., Santa Barbara, CA (USA). Center for Advanced Studies). Jan 1979. Contract EPA-68-03-2449. 224p. NTIS PC A10/MF A01.

This document considers the various production processes (mining, retorting, and oil upgrading) and key environmental factors (organic and inorganic characterization, environmental control, and limitations) related to oil shale development. This state-of-the-art survey supports a study designing a groundwater quality monitoring program for oil shale operations such as that proposed for Federal Oil Shale Lease Tracts U-a and U-b located in northeastern Utah. Hence, the reports emphasize technologies applicable to this development while also providing a general overview of oil shale technology.

IN SITU METHODS, TRUE AND MODIFIED

REFER ALSO TO CITATION(S) 11285, 11286

11280 (LETC—10787-28) **Investigation of the geokinetics horizontal in situ oil shale retorting process. Quarterly report, January-March 1979.** Mankowski, S.G. (Geokinetics, Inc., Concord, CA (USA)). Jun 1979. Contract ET-78-C-03-1787. 118p. Dep. NTIS, PC A06/MF A01.

Progress is reported on site preparation, drilling and blasting, retort burn, oil production, examination, environmental research, etc. Reports of (seismic) retort No. 19 blast, retort No. 10 gas, retort No. 16 oil analysis, and water quality studies are included as appendices. 19 figures, 24 tables. (DLC)

11281 (UCID—18524) **Proposed operating strategy for a field mis oil shale retorting experiment (RBOSC Retort O).** Braun, R.L.; Campbell, J.H.; McKenzie, D.R.; Raley, J.H.; Gregg, M.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jan 1980. Contract W-7405-ENG-48. 28p. Dep. NTIS, PC A03/MF A01.

A possible operating strategy for a field scale retort (similar to Retort 0) proposed by the Rio Blanco Oil Shale Company (RBOSC)) is discussed. This retorting strategy was developed based on model calculations, pilot retort experiments, and laboratory work carried out at LLL. From these calculations a set of operating conditions are derived that appear to give the best overall retort performance. A performance monitoring strategy is being developed based solely on the exit gas and oil composition.

11282 (UCRL—83006) **Scoping of fusion-driven retorting of oil shale.** Galloway, T.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nov 1979. Contract W-7405-ENG-48. 11p. (CONF-791102—69). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

In the time frame beyond 2005, fusion reactors are likely to make their first appearance when the oil shale industry will probably be operating with 20% of the production derived from surface retorts operating on deep mined shale from in situ retorts and 80% from shale retorted within these in situ retorts using relatively fine shale uniformly rubblized by expensive mining methods. A process was developed where fusion reactors supply a 600°C mixture of nitrogen, carbon dioxide, and water vapor to both surface and in situ retorts. The in situ production is accomplished by inert gas retorting, without oxygen, avoiding the burning of oil released from the larger shale particles produced in a simpler mining method. These fusion reactor-heated gases retort the oil from four 50x50x200m in-situ rubble beds at high rate of 40m/d and high yield (i.e., 95% F.A.), which provided high return on investment around 20% for the syncrude selling at $20/bbl, or 30% if sold as $30/bbl for heating oil. The bed of 600°C retorted shale, or char, left behind was then burned by the admission of ambient air in order to recover all of the possible energy from the shale resource. The hot combustion gases, mostly nitrogen, carbon dioxide and water vapor are then heat-exchanged with fusion reactor blanket coolant flow to be sequentially introduced into the next rubble bed ready for retorting. The advantages of this fusion-driven retorting process concept are a cheaper mining method, high yield and higher production rate system, processing with shale grades down to 50 l/mg (12 gpt), improved resource recovery by complete char utilization and low energy losses by leaving behind a cold, spent bed.

REFINING

REFER ALSO TO CITATION(S) 11087

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 11275, 12268

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 11284

ENVIROMENTAL ASPECTS

REFER ALSO TO CITATION(S) 11274, 11276, 11279

11283 (COO—4043-2) **Analysis of the environmental control technology for tar sand development.** de Nevers, N.; Glenne, B.; Bryner, C. (Utah Univ., Salt Lake City (USA). Coll. of Engineering). Jun 1979. Contract EY-76-S-02-4043. 293p. Dep. NTIS, PC A13/MF A01.

The environmental technology for control of air pollution, water pollution, and for the disposal, stabilization, and vegetation of the waste tar sand were thoroughly investigated. Although some difficulties may be encountered in any of these undertakings, it seems clear that the air and water pollution problems can be solved to meet any applicable standard. Currently there are two large-scale plants producing liquid fuels from tar sands in Alberta, Canada which use similar technology involving surface mining, hot water extraction, and surface disposal of waste sand. These projects all meet the Canadian environmental control regulations in force at the time they began. The largest US deposits of tar sands are much smaller than the Canadian; 95 percent are located in the state of Utah. Their economics do not appear as attractive as the Canadian deposits. The environmental control costs are not large enough to make an otherwise economic project uneconomic. The most serious environmental conflict likely to occur over the recovery of liquid fuels from the US deposits of tar sands is that caused by the proximity of the deposits to national parks, national monuments, and a national recreation area in Utah. These areas have very stringent air pollution requirements; and even if the air pollution control requirements can be met, there may still be adequate opposition to large-scale mining ventures in these areas to prevent their commercial exploitation. Another environmental constraint may be water rights availability.Essentially all of the water running in the Colorado river basin is now legally allocated. Barring new interpretations of the legality of water rights purchase, Utah tar sands developments should be able to obtain water by purchasing existing irrigation water rights.

11284 (DOE/EDP—0051) **Environmental development plan: oil shale.** (Department of Energy, Washington, DC (USA). Office of Fossil Energy). Nov 1979. 83p. Dep. NTIS, PC A05/MF A01.

The present DOE program includes shale oil production research on true in situ methods, modified in situ methods, aboveground methods, and advanced processing technology; gas production research targeted to both eastern and western oil shales; and supporting research for oil shale processing and control technology. DOE policy is that surface retorting is, technologically speaking, ready for commercialization. However, an assessment of information available to date on all methods has identified specific uncertainties and concerns that have implications for the future environmental acceptability of commercial development. These concerns are associated with air quility, water resources and quality, land disturbance, ecological effects, human health, occupational health and safety, transport and end use, socioeconomic, and compliance.

11285 (FE—2346-46) **Environmental monitoring and analysis in support of Antrim oil shale research. Topical report, March 1978-February 1979.** Tanis, F.J.; Thomas, G.S. (Environmental Research Inst. of Michigan, Ann Arbor (USA)). May 1979. Contract EX-76-C-01-2346. 174p. Dep. NTIS, PC A08/MF A01.

A program to assess environmental impacts of in situ Antrim oil shale processing experiments was carried out. This report covers the second year of an expected four year program. Activities included: monitoring of surface elevations for possible subsidence; monitoring for soil contamination from brines; monitoring surface and subsurface water quality; and monitoring ambient air quality. Assessment was also made of site vegetation, soils, surface disruption caused by drilling activities, and impacts on neighboring residents. Much of this year's effort was directed to monitoring baseline conditions. Consequently, assessment of potential impacts from in situ operations is not yet possible. However, hydrofracturing operations did not appear to affect surface elevations, and the experimental operations, including flaring of combustion product gases, did not degrade ambient air quality beyond permissible concentrations. Negative impacts noted include minor inconvenience to neighboring residents, ad physical disruption of the land surface. A potential

ground water quality problem caused by drilling wastes and/or well seepage from previous operations was identified.

11286 Draft environmental statement: proposed superior oil company land exchange and oil shale resource development. Denver, CO; State Bureau of Land Management (1979). 108p.

The Superior Oil Company requested an exchange of public land for private land. With the exchange, an economical mining unit would be formed and oil shale resources developed. Major federal actions would be the revoking of the oil shale withdrawal by the Secretary of the Interior and the exchange of land by the Bureau of Land Management. Following the exchange, Superior would construct an underground mine and a processing plant. The mine would produce an average of about 26,000 tons of oil shale daily. From the oil shale, the plant would produce about 4800 tons of nahcolite, 11,500 barrels of shale oil, 580 tons of alumina, and 1000 tons of soda ash daily. Production would continue for about 20 years. Aboveground facilities would occupy about 380 acres. Approximately 920 people would be employed during operation of the project. Products would be hauled from the plant by truck.

NUCLEAR FUELS

RESERVES

11287 (GJBX—1(80)) **Precambrian uranium-bearing quartz-pebble conglomerates: exploration model and United States resource potential.** Houston, R.S.; Karlstrom, K.E. (Wyoming Univ., Laramie (USA). Dept. of Geology). Nov 1979. Contract EY-76-C-13-1664. 528p. Dep. NTIS, PC A23/MF A01.

Uranium has been discovered in fluvial quartz-pebble conglomerates in most of the Precambrian shield areas of the world, including the Canadian, African, South American, Indian, Baltic, and Australian shields. Occurrences in these and other areas are shown. Two of these occurrences, the Huronian supergroup of Canada and the Witwatersrand deposit of South Africa contain 20 to 30 percent of the planet's known uranium reserves. Thus it is critical that we understand the origin of these deposits and develop exploration models that can aid in finding new deposits. Inasmuch as these uranium-bearing conglomerates are confined almost entirely to rocks of Precambrian age, Part I of this review begins with a discussion of Precambrian geology as it applies to the conglomerates. This is followed by a discussion of genetic concepts, a discussion of unresolved problems, and finally a suggested exploration model. Part II summarizes known and potential occurrences of Precambrian fossil placers in the world and evaluates them in terms of the suggested exploration model. Part III discusses the potential for important Precambrian fossil-placer uranium deposits in the United States and includes suggestions that may be helpful in establishing an exploration program in this country. Part III also brings together new (1975-1978) data on uranium occurrences in the Precambrian of the Wyoming Province. Part IV is a complete bibliography of Precambrian fossil placers, divided according to geographical areas. In total, this paper is designed to be a comprehensive review of Precambrian uranium-bearing fossil placers which will be of use to uranium explorationists and to students of Precambrian geology.

11288 (LA—8189-PR) **Oklo: natural fission reactor program. Progress report, July 1-September 30, 1979.** Norris, A.E. (Los Alamos Scientific Lab., NM (USA)). Jan 1980. Contract W-7405-ENG-36. 11p. Dep. NTIS, PC A02/MF A01.

Nearly 200 samples were collected at the Oklo mine in Gabon this quarter for shipment to the United States to continue studies of lead, ruthenium, and technetium migration around natural fission reactors. The first analyses of samples collected near a rich uranium ore body in Canada show the presence of radiogenic lead in pyrite and sandstone materials. Analyses of additional samples are underway to permit the interpretation of the data in terms of transport paths. A technique was developed this quarter to eliminate the interference of organic materials during the mass spectrometric analyses of ruthenium in Oklo samples with high asphaltic contents. A proposal was drafted for a study of naturally occurring radionuclide migration at rich uranium ore bodies in Australia to be performed jointly by the US Department of Energy and the Australian Atomic Energy Commission.

EXPLORATION

REFER ALSO TO CITATION(S) 11287

11289 (GJBX—9(80)(Vol.1)) **Aerial gamma ray and magnetic survey: Raton Basin Project. The Raton and Santa Fe Quadrangles of New Mexico. Final report.** (EG and G GeoMetrics, Sunnyvale, CA (USA)). Nov 1979. Contract EY-76-C-13-1664. 80p. Dep. NTIS, PC E06/MF E06.

In 1978, EG & G geoMetrics collected 4955 line miles of high sensitivity airborne radiometric and magnetic data in New Mexico within the Raton and Santa Fe quadrangles. These quadrangles represent part of the Raton Basin Project. All radiometric and magnetic data for the two quadrangles were fully reduced and interpreted by geoMetrics, and are presented as three volumes; one Volume I covering both quadrangles and separate Volume II's for the individual quadrangles. Over 50% of the survey area is covered by flat lying Mesozoic and Cenozoic deposits of the southern Great Plains Province. The western and southern portions of the area contain a combination of Precambrian and Paleozoic igneous and metamorphic rocks. These rocks occur primarily within and in close proximity to the Sangre de Cristo Mountains and late Cenozoic volcanic deposits occur to the west of the mountains and in the Las Vegas Volcanic region. Uranium deposits are scattered throughout the region, but none are known to be economic at the time of this report.

11290 (GJBX—9(80)(Vol.2)(Raton)) **Aerial gamma ray and magnetic survey: Raton Basin Project. The Raton and Santa Fe Quadrangles of New Mexico. Final report.** (EG and G GeoMetrics, Sunnyvale, CA (USA)). Nov 1979. Contract EY-76-C-13-1664. 216p. Dep. NTIS, PC A10/MF A01.

The Raton quadrangle in northern New Mexico lies principally within the Southern Rocky Mountains and Great Plains Province. The eastern half of the quadrangle contains portions of the Raton and Las Vegas Basins, and the Sierra Grande Arch in the Great Plains Province. The west is dominated by the Sangre de Cristos and related mountain ranges of the Southern Rockies, but grades into the Rio Grande Rift Zone in the far west. Many areas in the quadrangle contain significant amounts of Cretaceous through Quaternary igneous rocks of a variety of types. Magnetic data reflect both deep and shallow sources. The basins show as regions of low frequency low amplitude wavelengths except where significant amounts of igneous rocks are exposed. The Raton quadrangle has been unproductive in terms of uranium. All known uranium occurrences to date have proven uneconomic. A total of 98 uranium anomalies are valid according to the criteria set forth in Volume I. These anomalies are scattered throughout the quadrangle. However, they fail to outline the most significant area in terms of its count rate, because of extremely high apparent thorium concentrations.

11291 (GJBX—12(80)(Vol.1)) **NURE aerial gamma-ray and magnetic reconnaissance survey, Colorado-Arizona area: Salton Sea NI II-9, Phoenix NI 12-7, El Centro NI II-12, AJO NI 12-10, Lukeville NH 12-1 quadrangles. Volume I. Narrative report.** (LKB Resources, Inc., Huntingdon Valley, PA (USA)). Nov 1979. Contract EY-76-C-13-1664. 258p. Dep. NTIS, PC E10/MF E10.

A rotary-wing reconnaissance high sensitivity radiometric and magnetic survey, encompassing several 1:250,000 quadrangles in southwestern Arizona and southeastern California, was performed. The surveyed area consisted of approximately 9300 line miles. The radiometric data were corrected and normalized to 400 feet terrain clearance. The data were identified as to rock type by correlating the data samples with existing geologic maps. Statistics defining the mean and standard deviation of each rock type are presented as listings in Volume I of this report. The departure of the data from its corresponding mean rock type is computed in terms of standard deviation units and is presented graphically as anomaly maps in Volume II and as computer listings in microfiche form in Volume I. Profiles of the normalized averaged data are contained in Volume II and include traces of the potassium, uranium and thorium count rates, corresponding ratios, and several ancilliary sensor data traces, magnetometer, radio altimeter and barometric pressure height. A description of the local geology is provided, and a discussion of the magnetic and radiometric data is presented together with an evaluation of selected uranium anomalies.

11292 (GJBX—12(80)(Vol.2)(Phoenix)) **NURE aerial gamma-ray and magnetic reconnaissance survey: Colorado-Arizona area, Salton Sea NI 11-9, El Centro NI 11-12, Phoenix NI 12-7, Ajo NI 12-10, Lukeville NH 12-1 quadrangles.** (LKB Resources, Inc., Huntingdon Valley, PA (USA)). Nov 1979. Contract EY-76-C-13-1664. 212p. Dep. NTIS, PC A10/MF A01.

Volume II contains the geologic base map, flight path map, anomaly maps (uranium, thorium, potassium, uranium/thorium, uranium/potassium, thorium/potassium), radiometric multiple-parameter stacked profiles, magnetic and ancillary stacked profile data, and histograms.

11293 (GJBX—12(80)(Vol.2)(SaltonSea)) **NURE aerial gamma-ray and magnetic reconnaissance survey: Colorado-Arizona area, Salton Sea NI 11-9, El Centro NI 11-12, Phoenix NI 12-7, Ajo NI 12-10, Lukeville NH 12-1 quadrangles.** (LKB Resources, Inc., Huntingdon Valley, PA (USA)). Nov 1979. Contract EY-76-C-13-1664. 235p. Dep. NTIS, PC A11/MF A01.

Volume II contains the geologic base map, flight path map, anomaly maps (uranium, thorium, potassium, uranium/thorium, uranium/potassium, thorium/potassium), radiometric multiple-parameter stacked profiles, magnetic and ancillary stacked profile data, and histograms.

11294 (GJBX—13(80)(Vol.1)) **Aerial gamma ray and magnetic survey: Minnesota Project, Thief River Falls, Grand Forks, Fargo, Milbank, Watertown, New Ulm and St. Cloud quadrangles of North Dakota, South Dakota and Minnesota. Final report.** (GeoMetrics, Inc., Sunnyvale, CA (USA)). Oct 1979. Contract EY-76-C-13-1664. 72p. Dep. NTIS, PC05/MF E05.

During the months of August and September 1979, geoMetrics, Inc., collected 12,415 line miles of high sensitivity airborne radiometric and magnetic data in adjoining portions of South Dakota and Minnesota over seven 1 by 2 degree NTMS quadrangles (Thief River Falls, Grand Forks, Fargo, Milbank, Watertown, New Ulm, and St. Cloud) as part of the Department of Energy's National Uranium Resource Evaluation Program. All radiometric and magnetic data were fully corrected and interpreted by geoMetrics and are presented as eight volumes (one Volume I and seven Volume II's). Regional geology for these seven quadrangles can be divided into two logical sections. The first comprises the surficial glacial deposits, which mantle most of the area and can be up to hundreds of feet thick. The second section consists of the underlying bedrock which is exposed in small scattered outcrops, generally along major drainages. No sedimentary structures exist within the quadrangles. As of this writing, no known uranium deposits exist within the seven quadrangles.

11295 (GJBX—15(80)) **Aerial radiometric and magnetic survey: Escalante National Topographic Map, Arizona and Utah.** (Geodata International, Inc., Dallas, TX (USA)). 1980. Contract EY-76-C-13-1664. 366p. Dep. NTIS, PC E14/MF E14.

The results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Escalante National Topographic Map NJ12-8 are presented. The airborne data gathered are reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included, with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included also.

11296 (GJBX—16(80)(Vol.2)) **NURE aerial gamma-ray and magentic reconnaissance survey: Colorado-Arizona area, Marble Canyon NJ 12-11 quadrangle.** (LKB Resources, Inc., Huntingdon Valley, PA (USA)). Nov 1979. Contract EY-76-C-13-1664. 180p. Dep. NTIS, PC A09/MF A01.

The departure of the radiometric data from its corresponding mean rock type is computed in terms of standard deviation units and is presented graphically as anomaly maps. Profiles of the normalized averaged data include traces of the potassium, uranium, and thorium count rates, corresponding ratios, and several ancillary sensor data traces, magnetometer radio altimeter and barometric pressure height.

11297 (GJBX—20(80)) **Aerial radiometric and magnetic survey: Klamath Falls National Topographic Map, California and Oregon.** (Geodata International, Inc., Dallas, TX (USA)). 1980. Contract EY-76-C-13-1664. 298p. Dep. NTIS, PC E14/MF E14.

The results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Klamath Falls National Topographic Map NK10-6 are presented. The airborne data gathered are reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included, with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included also.

11298 (K/UR—100) **National Uranium Resource Evaluation Program. Hydrogeochemical and stream sediment reconnaissance procedures of the uranium resource evaluation project.** Arendt, J.W.; Butz, T.R.; Cagle, G.W.; Kane, V.E.; Nichols, C.E. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 31 Dec 1979. Contract W-7405-ENG-26. 53p. Dep. NTIS, PC A04/MF A01.

Purpose of this addendum is to provide the reader of the basic data report and the detailed geochemical survey report with a readily obtainable reference explaining the overall ORGDP reporting program in detail. The document describes specific procedures used concerning field and laboratory methodology and quality control. Different types of data presentations used in the basic data reports are defined and explained in detail.

11299 (UCRL—52686) **Hydrogeochemical and stream sediment special reconnaissance report for the Deep Creek Mountains, Nevada and Utah.** Qualheim, B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1979. Contract W-7405-ENG-48. 257p. Dep. NTIS, PC E06/MF E06.

This report represents the results of the reconnaissance sampling of the Deep Creek Mountains of western Utah. The Deep Creek range is located in the northwest corner of the Delta NTMS 1:250,000 and the southwestern corner of the Tooele NTMS 1:250,000 sheets and covers an area of 1750 km^2. Samples collected in this study include dry and wet stream sediments and water from available streams, wells, and springs. The samples were analyzed for uranium, as well as 15 to 20 trace elements, using neutron activation techniques. In addition, field and laboratory measurements were made on the water samples. Analytical data and field measurements are presented in tabular hard copy and fiche format. Water-sample site locations, water-sample uranium concentrations, sediment-sample site locations, and sediment-sample uranium concentrations are shown on separate overlays.

11300 (GJBX—9(80)(Vol.2)(Sante-Fe)) **Aerial gamma ray and magnetic survey: Raton Basin Project. The Raton and Santa Fe Quadrangles of New Mexico. Final report.** (EG and G GeoMetrics, Sunnyvale, CA (USA)). Dec 1979. Contract EY-76-C-13-1664. 324p. Dep. NTIS, PC A14/MF A01.

The Santa Fe quadrangle in central New Mexico lies principally within the Southern Rocky Mountains and Great Plains Provinces. The west is dominated by the Sangre de Cristo Mountains. The eastern and southern regions contain portions of the Sierra Grande Arch and the Las Vegas and Tucumcari Basins. These structures primarily contain Permian, Triassic, Cretaceous, and Tertiary sediments. Many areas of the quadrangle are covered by Cretaceous through Quaternary igneous rocks of a variety of types. Magnetic data reflect both deep and shallow sources. The basins show as regions of low frequency/low amplitude wavelengths except where significant amounts of igneous rocks are exposed. The Santa Fe quadrangle has been unproductive in terms of uranium. All known uranium occurrences to date have proven uneconomic. A total of 219 uranium anomalies are valid according to the criteria set forth in Volume I. Two groups of anomalies in the Sangre de Cristo Mountains appear to be most significant in terms of their peak count rates.

11301 (GJBX—12(80)(Vol.2)(Ajo-NI)) **NURE aerial gamma-ray and magnetic reconnaissance survey: Colorado-Arizona area, Salton Sea NI 11-9, El Centro NI 11-12, Phoenix NI 12-7, Ajo NI 12-10, Lukeville NH 12-1 quadrangles.** (LKB Resources, Inc., Huntingdon Valley, PA (USA)). Nov 1979. Contract EY-76-C-13-1664. 201p. Dep. NTIS, PC A10/MF A01.

Volume II contains the geologic base map, flight path map, anomaly maps (uranium, thorium, potassium, uranium/thorium, uranium/potassium, thorium/potassium), radiometric multiple-parameter stacked profiles, magnetic and ancillary stacked profile data, and histograms.

MINING

REFER ALSO TO CITATION(S) 11367

11302 (DOE/TIC—11072) **Preliminary map No. 28: mine location map and ore production data, Lukachukai Mountains, Apache County, Arizona.** Learned, E.A. (comp.). (Bendix Field Engineering Corp., Grand Junction, CO (USA)). Jan 1979. Contract EY-76-C-13-1664. 16p. Dep. NTIS, PC A02/MF A01.

A mine location map and ore production data (uranium/vanadium) for Lukachukai Mountains, Apache County, Arizona, are presented.

FEED PROCESSING

REFER ALSO TO CITATION(S) 11337, 11365, 11367

11303 (BM-RI—8393) **Extraction of uranium from carbonaceous sandstone materials.** Nichols, I.L.; Lawrence, A.G.; Seidel, D.C. (Bureau of Mines, Salt Lake City, UT (USA). Salt Lake City

Metallurgy Research Center). 1979. 19p. Bureau of Mines, Pittsburgh, PA.

Laboratory characterization studies have investigated the processing variability of carbonaceous uranium-bearing materials found in sandstone deposits. This work was conducted by the Federal Bureau of Mines in support of its goal to maintain an adequate supply of minerals to meet national economic and strategic needs. Conventional processing produces only partial uranium recovery from these ore materials. Ore samples from New Mexico, Texas, and Wyoming were examined, and each responded differently. Using direct acid leaching techniques, some of the ores required acid additions of only 50 pounds per ton, while others required 300 pounds per ton of material. Maximum extractions ranged from 83 to 94 percent in the six ores tested. Roasting those ores prior to leaching improved extraction of the uranium to the 90 to 99 percent range. An oxidative autoclave treatment used with five of these ores resulted in extraction of 78 to 97 percent of the uranium. The experimental studies also showed that some carbonaceous materials can be concentrated by froth flotation. The flotation tailings were amenable to acid leaching, and up to 98 percent of the uranium was extracted from this type of material.

11304 (ORNL/TM—7182) **Uranium recovery from wet-process phosphoric acid with octylphenyl acid phosphate. Progress report.** Arnold, W.D.; McKamey, D.R.; Baes, C.F. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 64p. Dep. NTIS, PC A04/MF A01.

Studies were continued of a process for recovering uranium from wet-process phosphoric acid with octylphenyl acid phosphate (OPAP), a mixture of mono- and dioctylphenyl phosphoric acids. The mixture contained at least nine impurities, the principal one being octyl phenol, and also material that readily hydrolyzed to octyl phenol and orthophosphoric acid. The combination of mono- and dioctylphenyl phosphoric acids was the principal uranium extractant, but some of the impurities also extracted uranium. Hydrolysis of the extractant had little effect on uranium extraction, as did the presence of moderate concentrations of octyl phenol and trioctylphenyl phosphate. Diluent choice among refined kerosenes, naphthenic mixtures, and paraffinic hydrocarbons also had little effect on uranium extraction, but extraction was much lower when an aromatic diluent was used. Purified OPAP fractions were sparingly soluble in aliphatic hydrocarbon diluents. The solubility was increased by the presence of impurities such as octyl phenol, and by the addition of water or an acidic solution to the extractant-diluent mixture. In continuous stability tests, extractant loss by distribution to the aqueous phase was much less to wet-process phosphoric acid than to reagent grade acid. Uranium recovery from wet-process acid decreased steadily because of the combined effects of extractant poisoning and precipitation of the extractant as a complex with ferric iron. Unaccountable losses of organic phase volume occurred in the continuous tests. While attempts to recover the lost organic phase were unsuccessful, the test results indicate it was not lost by entrainment or dissolution in the phosphoric acid solutions. 21 figures, 8 tables.

11305 (PB—293029) **Coupled transport membranes for metal separations. Final report on phase 3, May 1975-May 1978.** Babcock, W.C.; Baker, R.W.; Kelly, D.J.; Lonsdale, H.K. (Bend Research, Inc., OR (USA)). May 1978. Contract H0252066. 93p. NTIS, PC A05/MF A01.

The report covers Phase III of a continuing program to apply a new membrane process--coupled transport--to the separation and concentration of copper and uranium from hydrometallurgical leach solutions. During Phases I and II of this program, the basic feasibility and economic viability of the process was demonstrated with laboratory cells and with copper leach solutions. During this third phase, small bench-scale membrane separation units were constructed, consisting of three to four hollow fiber modules with a total surface area of up to 100 sq ft. These units were used to define the process system parameters for copper recovery. During the course of these studies, mechanical problems with the hollow fiber membrane modules surfaced which delayed completion of the module stability and field trial portion of the program. In all other aspects, the units worked well, yielding high concentration and moderate separation factors and good fluxes. The technical feasibility of separating and concentrating uranium from leach liquors using tertiary amine agents was also demonstrated. High concentration and separation factors resulted at fluxes that appear to make coupled transport membranes for uranium separations competitive with existing techniques.

11306 (PB—293578) **Heap leaching studies on uranium ore. phase V: experimental studies. Open file report 15 August 1977-4 December 1978.** Merritt, R.; Peterson, H.; Wentz, C.; Harris, M. (Colorado School of Mines, Golden (USA). Research Inst.). Nov 1978. Contract HO252022. 221p. NTIS, PC A10/MF A01.

Experimental studies were conducted on a low-grade ore procured from Wyoming. The ore was characterized as primarily sandstone with a trace of clay mineralization and had a U_3O_8 content of 0.029%. Preliminary laboratory studies were conducted on the ore sample to determine the response of the ore to acid and carbonate lixiviants. The studies showed that acid leaching by agitation and by 2-in column percolation gave 97% and 99% U_3O_8 extraction. The studies also showed that the ore was less responsive to carbonate leaching than to acid leaching. Tests conducted using a sodium carbonate lixiviant gave 69% and 82% U_3O_8 extraction for the agitation and percolation studies. Tests conducted using an ammonium carbonate lixiviant gave 39% and 83% U_3O_8 extraction for the agitation and percolation studies. Subsequent pilot plant studies consisted of nine percolation leach tests conducted in 2-ft diam columns, and one small-scale heap leach. These studies showed that the percolation tests using an acid lixiviant resulted in greater than 96% U_3O_8 extraction, whereas the percolation tests using carbonate lixiviants resulted in approximately 87% U_3O_8 extraction. The pilot plant studies using acid solution showed that the rate of U_3O_8 extraction was directly proportional to the flow rate.

11307 **Chemistry of protactinium, neptunium, americium, and curium in the nuclear fuel cycle.** Keller, O.L. Jr. (Oak Ridge National Lab., TN (USA)). *Radiochim. Acta;* **25**: No. 3-4, 211-223(1978).

A review of the chemistry of the actinide elements protactinium, neptunium, americium, and curium is given with a focus on their most important roles in the nuclear fuel cycle. The chemistry of Pa in molten salts and molten bismuth as it relates to a conceptual Molten Salt Breeder Reactor is given, followed by a discussion of its behavior in aqueous systems. The principal reactions of neptunium, particularly as they relate to control of oxidation states, are presented for the Purex process. And finally a discussion is given of the new reagents and processes being developed for partitioning of Am(III) and CU(III) from fission products in high level wastes.

11308 **Conversion of uranium trioxide to uranium hexafluoride.** Pashley, J.H. (Oak Ridge Gaseous Diffusion Plant, TN (USA). Enrichment Technology Div.). *Radiochim. Acta;* **25**: No. 3-4, 135-138(1978).

Processes for conversion of UO_3 to UF_6 for use in the isotopic enrichment part of the fuel cycle have been operated on a tons/day scale for decades. The basic route which involves reduction of UO_3 to UO_2 with H_2, followed by conversion to UF_4 with HF, and then fluorination with elemental F_2 to give UF_6, is described with discussion of some of the key technology points. Limited comments on methods of purification of the UF_6 and on alternative conversion routes are presented.

ENRICHMENT

11309 **Isotope separation process.** Thomas, W.R.L. (to Exxon Research & Engineering Co.). US Patent 4,155,822. 22 May 1979. Filed date 28 Dec 1977. 6p.

The instant invention relates to an improved process for separating a material into two or more parts in each of which the abundances of the isotopes of a given element differ from the abundances of the isotopes of the same element in said material. More particularly, the invention relates to a method for the isotopically selective excitation of gas phase molecules by multiple infrared photon absorption followed by a step wherein more of the excited molecules than non-excited molecules are converted to a chemically different form which may be separated by means known in the art. This invention is useful for, but not limited to, the separation of the principal isotopes of uranium.

CENTRIFUGATION

11310 **Gas-centrifuge unit and centrifugal process for isotope separation.** Stark, T.M. (to Exxon Nuclear Co., Inc.). US Patent 4,167,244. 11 Sep 1979. Filed date 11 Nov 1976. 30p.

An invention involving a process and apparatus for isotope-separation applications such as uranium-isotope enrichment is disclosed which employs cascades of gas centrifuges. A preferred apparatus relates to an isotope-enrichment unit which includes a first group of cascades of gas centrifuges and an auxiliary cascade. Each cascade has an input, a light-fraction output, and a heavy-fraction output for separating a gaseous-mixture feed including a compound of a light nuclear isotope and a compound of a heavy nuclear isotope into light and heavy fractions respectively enriched and depleted in the light isotope. The cascades of the first group have at least one enriching stage and at least one stripping stage. The unit further includes means for introducing a gaseous-mixture feedstock into each input of the first group of cascades, means for withdrawing at least a portion of a product fraction from the light-fraction outputs of the first group of cascades, and means for withdrawing at least a portion of a waste fraction from the heavy-fraction outputs of the first group of cascades. The isotope-enrichment unit also includes a means for conveying a gaseous-mixture from a light-fraction output of a first cascade included in the first group to the input of the auxiliary cascade so that at least a portion of a light gaseous-mixture

fraction produced by the first group of cascades is further separated into a light and a heavy fraction by the auxiliary cascade. At least a portion of a product fraction is withdrawn from the light fraction output of the auxiliary cascade. If the light-fraction output of the first cascade and the heavy-fraction output of the auxiliary cascade are reciprocal outputs, the concentraton of the light isotope in the heavy fraction produced by the auxiliary cascade essentially equals the concentration of the light isotope in the gaseous-mixture feedstock.

LASER EXCITATION

REFER ALSO TO CITATION(S) 12234

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 11386

11311 (PNL—3134) **Hybrid pellets: an improved concept for fabrication of nuclear fuel.** Matthews, R.B.; Hart, P.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Sep 1979. Contract EY-76-C-06-1830. 56p. Dep. NTIS, PC A04/MF A01.

The feasibility of fabricating fuel pellets using gel-derived microspheres as press feed was evaluated. By using gel-derived microspheres as press feed, the potential exists for eliminating dusty operations like milling, slugging, and granulation, from the pelleting process. The free-flowing character of the spheres should also result in limited dust generation during powder transport and pressing operations. The results of this study clearly demonstrate that fuel pellets can be successfully fabricated on a laboratory scale using UO_2 gel microspheres as press feed. Under moderate sintering conditions, 1,500°C for 4 h in Ar-4% H_2, UO_2 pellets with densities up to 96% TD were fabricated. A range of pellet microstructures and densities were achieved depending on sphere forming and calcining conditions. Based on these results, a set of necessary sphere properties are suggested: O/U less than 2.20, crystallite size less than 500 A, specific surface area greater than 8 m^2/g, and sphere size 200 and 400 μm. Preliminary attempts to fabricate ThO_2 and ThO_2-UO_2 pellets using microspheres were unsuccessful because the requisite sphere properties were not achieved. Areas requiring additional development include: demonstration of the process on scaled-up equipment suitable for use in a remote fuel fabrication facility and evaluation of the irradiation performance of pellet fuels from gel-spheres.

11312 (RPDE—79-040) **Pneumatic transport system development. Final report.** Smeltzer, E.E.; Eckhardt, D.A.; Yang, W.C.; Skriba, M.C. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Nuclear Energy Systems Div.). Feb 1979. Contract EN-77-C-06-1058-002. 348p. Dep. NTIS, PC A15/MF A01.

Data on solids transfer rates, system reliability, residual material in the system, degree of homogeneity before and after transport of blended nuclear fuel powders, erosion in the elbows, and materials of construction were generated to provide confirmation of the design criteria necessary for the implementation of a dilute phase pneumatic transport system in a commercial mixed oxide fuel facility. From the conclusions derived from this test program, it is recommended that a dilute phase, negative pressure driven, pneumatic transport system be retained as the design of the Recycle Fuels Plant, since it essentially fulfills all the requirements for bulk handling of fine powders in such a facility.

11313 **Thorium utilization.** Trauger, D.B. (Oak Ridge National Lab., TN (USA)). *Ann. Nucl. Energy;* **5**: No. 8, p. 375-403(1978).

From Seminar on thorium and gas cooled reactors; San Diego, CA, USA (17 Jun 1978).

Some of the factors that provide incentive for the utilization of thorium in specific reactor types are explored and the constraints that stand in the way are pointed out. The properties of thorium and derived fuels are discussed, and test and reactor operating experience is reviewed. In addition, symbiotic systems of breeder and converter reactor are suggested as being particularly attractive systems for energy production. Throughout the discussion, the High-Temperature Gas-Cooled Reactor and Molten Salt Reactor are treated in some detail because they have been developed primarily for use with thorium fuel cycles.

11314 **Preparation of HTGR fissile fuel kernels by uranium-loading of ion exchange resins.** Notz, K.J.; Haas, P.A.; Schaffer, J.H. (Oak Ridge National Lab., TN (USA). Chemical Technology Div.). *Radiochim. Acta;* **25**: No. 3-4, 153-160(1978).

Fissile fuel for High-Temperature Gas-Cooled Reactors (HTGRs) is fabricated in the form of small spheres ca. 300 μm in diameter, each containing ca. 70 μg of highly enriched uranium; the preferred chemical composition is a mixture of oxide and carbide. This report describes a process for loading weakacid ion exchange resin beads with uranium, from which the desired product is then derived by thermal treatment. The process is based on the exchange of uranyl ion with the acid form of a carboxylate resin. In order to drive the reaction to essential completion, it is necessary to use acid-deficient uranyl nitrate. This solution composition can be achieved either by extraction of HNO_3 with an amine in an organic solvent or by reaction with UO_3. For recycle fuel, where uranyl nitrate solution is the natural product of reprocessing, amine extraction is preferred. For smaller operations, batch loading is the simpler approach; however, for larger operations, a single Higgins-type pulsed column can load 100 kg U per day in a continuous mode.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 11307, 11320, 11340, 12625

11315 (ANL—79-85) **Di-n-amyl-n-amylphosphonate and tricaprylmethylammonium nitrate as potential extractants for reprocessing Th-U fuels.** Diamond, H.; Sabau, C.S.; Horwitz, E.P.; Vandergrift, G.F.; Mason, G.W. (Argonne National Lab., IL (USA)). Sep 1979. Contract W-31-109-ENG-38. 45p. Dep. NTIS, PC A03/MF A01.

Both 2F di-n-amyl-n-amylphosphonate in n-dodecane (DA[AP]-DD) and 0.77F tricaprylmethylammonium nitrate in Aromatic 100 (TCMA.NO_3-AR100) extract uranium and thorium into relatively concentrated organic solutions. Countercurrent-flow tests with each extractant have demonstrated effective uranium-thorium separations by selective stripping from the organic phase. Both extractants offer advantageous alternatives to tributylphosphate (Thorex) in reprocessing irradiated mixed ThO_2-UO_2 fuels. Formic acid is used for removing thorium from DA[AP]-DD; dilute HNO_3 removes uranium from TCMA.NO_3-AR100. Spectra of plutonium in formic acid are shown. The use of concentrated TCMA.NO_3-AR100 at 50 to 65°C avoids viscosity problems and suppresses third-phase formation. Thorium extracts into concentrated TCMA.NO_3-AR100 in greater amounts than would be predicted from stoichiometric assumptions.

11316 **Photo and radiation chemistry in nuclear fuel reprocessing.** Bell, J.T.; Toth, L.M. (Oak Ridge National Lab., TN (USA). Chemistry Div.). *Radiochim. Acta;* **25**: No. 3-4, 225-230(1978).

Photo and radiation chemistry is discussed in the context of reprocessing spent nuclear fuels. Products that result from α, β, or γ radiation of solutes and solvents in aqueous or organic phases can affect separation schemes by reacting with actinides and fission products to change oxidation states or to form highly stable complexes and precipitates. Controlled photochemical redox reactions might be utilized to improve existing separation schemes. Photochemical redox reactions of actinide elements are potentially applicable to current processing technology, while use of photosubstitution reactions would require significant modifications to current processes.

11317 (LA—8149-PR) **Fission product release. Progress report, July 1-September 30, 1979.** Norris, A.E. (comp.). (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36; EY-76-C-06-1830. 18p. Dep. NTIS, PC A02/MF A01.

Experiments are being performed to measure the effects of aqueous reducing conditions, in comparison to oxidizing conditions, on the rate of dissolution of UO_2 and on the release of fission products from spent fuel element wafers. This quarter we determined that equilibrium or pseudoequilibrium conditions are established between the surface of the spent fuel wafers and the leachant solutions after a contact time of 20 days. An experiment was performed to measure the rate of dissolution of powdered UO_2 under reducing conditions, in which the UO_2 was treated just before the start of the experiment to remove surface oxygen. The rate of dissolution measured was two orders of magnitude higher than observed in a similar experiment in which no precautions were taken to remove surface oxygen from the UO_2. The reason for the differences in these two experiments is not understood. The surface area analyzer ordered for this program was delivered and found to function satisfactorily. It is being adapted for use in a hot cell.

11318 **Method for purifying plutonium hexafluoride.** Tsujino, T.; Nishimura, M.; Yamazaki, K.; Sugikawa, S. (to Japan Atomic Energy Research Inst.). US Patent 4,172,114. 23 Oct 1979. Priority date 3 Sep 1976, Japan, 4p.

An effective method for purifying plutonium hexafluoride for the reprocessing of the spent nuclear fuel or for the recovery of fuel plutonium from the scrap by fluoride-volatility with high decontamination factors is presented using a selective adsorption of the fission products fluorides by letting the gas mixture flow through a layer of an adsorbent consisting of one or more of the specified compounds selected from hexafluoro sodium aluminate, zinc fluoride, nickel fluoride and ferric fluoride at an elevated temperature. The principle of the purification method is based on the fact that the fluorides of the fission products are easily adsorbed by the adsorbent but little plutonium hexafluoride is adsorbed. The fluorides of the fission

products are easily removed from the adsorbent by heating and the recycling use of the adsorbent is possible.

11319 Chemistry of plutonium in sol-gel processes. Lloyd, M.H.; Haire, R.G. (Oak Ridge National Lab., TN (USA)). *Radiochim. Acta;* **25**: No. 3-4, 139-148(1978).

Studies of plutonium chemical behavior conducted in conjunction with plutonia sol-gel process development at ORNL are described. The colloidal solutions produced consist of 'Pu(IV) polymer,' and this is therefore the study of polymeric plutonium behavior. Spectrophotometric, electron diffraction, and electron microscopy studies, in addition to specific studies that were concerned with the colloidal behavior of Pu(IV) polymer, indicate several characteristics of polymer that are not generally recognized. The particle nature of Pu(IV) polymer indicated by electron microscopy, the amorphous-crystalline characteristics of primary polymer particles demonstrated by electron diffraction, and the reversible and irreversible aggregation of the primary particles shown by spectrophotometric techniques present a useful view of the nature of Pu(IV) polymer that has been helpful in solving or understanding various types of processing problems involving plutonium hydrolytic behavior. The colloidal characteristics of Pu(IV) polymer and crystallite growth of primary polymer particles by thermal denitration are also described.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 11367

11320 (AGNS—47921-TPR-1) Studies and research concerning BNFP. Technical progress report, October 1979-December 1979. (Allied-General Nuclear Services, Barnwell, SC (USA)). 25 Jan 1980. Contract ET-78-C-09-1040. 13p. Dep. NTIS, PC A02/MF A01.

Work on the AFR spent fuel storage program is focused on developing design and licensing information for the model facility. To date, the design effort is proceeding on schedule. A subcontract for soils and structural design of the fuel transfers canal is ready for DOE review. Proposals for high-density rack design to bring the model facility up to a nominal 1750 MTU capacity have been received and are being reviewed internally. This subcontract should be available for DOE review in early February. A security subcontract has been awarded to International Energy Associates Limited and the preliminary design effort is underway. Licensing activities are progressing satisfactorily. Review of the governing local, state, and federal regulations has been completed. Format and schedule for the safety analysis report and the environmental report have been established.

11321 (NTIS/PS—79/0704) Hazardous materials transportation. part 2. radioactive materials and wastes (citations from the NTIS data base). Report for 1964-Apr 1979. Carrigan, B. (National Technical Information Service, Springfield, VA (USA)). Jul 1979. 174p. NTIS PCN01/MF N01.

The bibliography cites studies on the hazards, risks, and uncertainty of transporting radioactive wastes and materials. The design of shipping containers and special labels for identification purposes for transporting fuels and wastes are also cited. Studies are included on legislation dealing with the safety and health of the population and the environmental problems associated with transporting radioactive materials. (This updated bibliography contains 167 abstracts, 27 of which are new entries to the previous edition.)

11322 (PNL-SA—6520) Risk of transporting spent nuclear fuel by truck. Elder, H.K.; Andrews, W.B.; Rhoads, R.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1978. Contract EY-76-C-06-1830. 10p. (CONF-780506—44). Dep. NTIS, PC A02/MF A01.

From 5. symposium on packaging and transportation of radioactive materials; Las Vegas, NV, USA (7 May 1978).

Portions of document are illegible.

The risk methodology used to evaluate the risk in shipping spent fuel includes: 1) a description of the spent fuel transport system, 2) identification of potential release sequences, 3) evaluation of the probabilities and consequences of the releases, and 4) calculation and assessment of the risk. The system description includes projected industry characteristics, amounts to be shipped, shipping package descriptions, material characteristics, transport mode, transport routes used and weather and population distribution information. Release sequences are identified by fault tree analysis tehniques. Releases are evaluated using package failure data, normal transport and transport accident environment data and mathematical models for material dispersion and resultant health effects. This information is combined to calculate the shipping system risk which is compared to other known risks. The data may be further analyzed to determine the primary contributors to the risk and identify possible methods for reducing the risk, if the current risk level is judged by society to be unacceptable.

11323 (PNL-SA—6527) Identification and prioritization of potential problems in nuclear material transportation, now through 2000. DeSteese, J.G.; Rhoads, R.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1977. Contract EY-76-C-06-1830. 7p. Dep. NTIS, PC A02/MF A01.

Specific potential problems are identified which collectively contribute to the uncertainties about future conditions and events that may frustrate the development of adequate and timely transportation for nuclear fuel cycle materials. In particular, the impacts of these uncertainties may include continuous changes, critical delays and escalating costs in the development of spent fuel and waste transportation systems. The management of these uncertainties is the aggregate potential problem to be faced in the next decade, with possibly the future growth of the nuclear power industry at stake. We recommend that the development of nuclear material transportation systems be organized as coordinated industry/government missions with specific performance objectives. Mission planning and control functions should be organized to produce contingency plans for managing the impacts of future uncertainties on a whole-system basis. These plans should be based on the dynamic modeling and continously updated assessment of future concern scenarios. This systems approach could directly lessen the potential impact of many concerns discussed in this paper and provide, in advance, an inventory of options to maintain the required integrity and schedule of system development. There are many opportunities for innovation in system development and organization which may mitigate the effects of potential problems.Innovation in communications is also required to focus on public attitudes and provide better coordination of program efforts. While the current outlook for nuclear material transportation in the United States is beset with potentially serious problems, the above avenues of action are a basis for guarded optimism that the situation can be improved.

11324 (PNL-SA—6530) Risks of shipping plutonium by truck, train, and cargo aircraft. Johnson, J.F.; Andrews, W.B. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1978. Contract EY-76-C-06-1830. 8p. (CONF-780506—46). Dep. NTIS, PC A02/MF A01.

From 5. symposium on packaging and transportation of radioactive materials; Las Vegas, NV, USA (7 May 1978).

Risk is defined as the product of the probability of a release of material to the environment and the consequences resulting from the release. The methodology is composed of four basic steps: a detailed description of the transportation system, the identification of possible material release sequences, the evaluation of the probabilities and the consequences of the releases, and calculation and assessment of the risk. The system description includes projected industry characteristics, amounts to be shipped and the number of shipments required, material characteristics, transport mode and carrier, container types, routes (and any restrictions), and weather and population zones. Release sequences are identified using fault tree analyses. Releases are evaluated using container failure data and mathematical models for dispersion and health effects. The risk is then calculated and compared to other known risks.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 11321

11325 (DP—78-125-4) Waste management program technical progress report, October-December 1978. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Jan 1980. Contract EY-76-C-09-0001. 156p. Dep. NTIS, PC A08/MF A01.

This quarterly report provides current information on operations and development programs for the management of radioactive wastes from the operation of the Savannah River Plant. The operational status and research progress are reported for the liquid waste treatment and storage facilities, the incinerator for solid waste, the solidification of waste in borosilicate glass, and siting of subsurface storage facilities.

11326 (DP—79-125-1) Waste management program technical progress report, January-March 1979. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Jan 1980. Contract EY-76-C-09-0001. 79p. Dep. NTIS, PC A05/MF A01.

This quarterly report provides current informaton on operations and development programs for the management of radioactive wastes from the operation of the Savannah River Plant. The operational status and research progress are reported for the liquid waste treatment and storage facilities, the incinerator for solid waste, the solidification of waste in borosilicate glass, and siting of subsurface storage facilities.

11327 (HEDL-TME—79-15) **Division of Waste Management programs. Progress report, July-December 1978.** Lerch, R.E.; Allen, C.R.; Richardson, G.L. (comps.). (Hanford Engineering Development Lab., Richland, WA (USA)). Jul 1979. Contract EY-76-C-14-2170. 86p. Dep. NTIS, PC A05/MF A01.

This is the eleventh progress report on Division of Waste Management programs. The report describes progress in the second half of 1978 on the following programs: intermediate-level waste solidification, chemical processing of combustible solid waste, and application of acid digestion to commercial wastes. The latter two programs were combined in October 1978 into a single program, acid digestion of combustible wastes.

11328 (NUREG—0644) **Radioactive waste processing and disposal.** (Department of Energy, Oak Ridge, TN (USA). Technical Information Center; Nuclear Regulatory Commission, Washington, DC (USA)). Jan 1980. 900p. (TID—3311-S9). Dep. NTIS, PC A99/MF A01.

This compilation contains 3597 citations/abstracts of foreign and domestic research reports, journal articles, patents, conference proceedings, and books, which were entered in the DOE Energy Information Data Base since July 1978. (DLC)

11329 (PNL—3152) **Leaching of actinides and technetium from simulated high-level waste glass.** Bradley, D.J.; Harvey, C.O.; Turcotte, R.P. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1979. Contract EY-76-C-06-1830. 104p. Dep. NTIS, PC A06/MF A01.

Leach tests were conducted using a modified version of the IAEA procedure to study the behavior of glass waste-solution interactions. Release rates were determined for Tc, U, Np, Pu, Am, Cm, and Si in the following solutions: WIPP B salt brine, NaCl (287 g/l), NaCl (1.76 g/l), $CaCl_2$ (1.66 g/l), $NaHCO_3$ (2.52 g/l), and deionized water. The leach rates for all elements decreased an order of magnitude from their initial values during the first 20 to 30 days leaching time. The sodium bicarbonate solution produced the highest elemental release rates, while the saturated salt brine and deionized water in general gave the lowest release. Technetium has the highest initial release of all elements studied. The technetium release rates, however, decreased by over four orders of magnitude in 150 days of leaching time. In the prepared glass, technetium was phase separated, concentrating on internal pore surfaces. Neptunium, in all cases except $CaCl_2$ solution, shows the highest actinide release rate. In general, curium and uranium have the lowest release rates. The range of actinide release rates is from 10^{-5} to 10^{-8} g/cm²/day. 25 figures, 7 tables.

11330 (PNL—3176) **^{85}Kr management trade-offs: a perspective to total radiation dose commitment.** Mellinger, P.J.; Hoenes, G.R.; Brackenbush, L.W.; Greenborg, J. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jan 1980. Contract EY-76-C-06-1830. 126p. Dep. NTIS, PC A07/MF A01.

Radiological consequences arising from the trade-offs for ^{85}Kr waste management from possible nuclear fuel resource recovery activities have been investigated. The reference management technique is to release all the waste gas to the atmosphere where it is diluted and dispersed. A potential alternative is to collect, concentrate, package and submit the gas to long-term storage. This study compares the radiation dose commitment to the public and to the occupationally exposed work force from these alternatives. The results indicate that it makes little difference to the magnitude of the world population dose whether ^{85}Kr is captured and stored or chronically released to the environment. Further, comparisons of radiation exposures (for the purpose of estimating health effects) at very low dose rates to very large populations with exposures to a small number of occupationally exposed workers who each receive much higher dose rates may be misleading. Finally, cost studies (EPA 1976 and DOE 1979a) show that inordinate amounts of money will be required to lower this already extremely small 80-year cumulative world population dose of 0.05 mrem/person (<0.001% of natural background radiation for the same time period).

11331 **Summary of the report to the President by the Interagency Review Group on Nuclear Waste Management.** *Nucl. Saf.;* **20**: No. 6, 706-721(Nov 1979).

On March 13, 1978, in response to the findings of an internal Department of Energy (DOE) task force which had reviewed the United States nuclear waste management program, President Carter established the Interagency Review Group (IRG) to formulate recommendations for the establishment of an administrative policy with respect to long-term management of nuclear wastes and supporting programs. Chaired by the Secretary of Energy, the IRG is composed of representatives of 14 government entities. The Nuclear Regulatory Commission (NRC) participated in the activities of the IRG as a nonvoting member. The IRG attempted to obtain a broad range of inputs and views from many sources, including Congress, state and local governments, Indian nations, industry, the scientific and technical community, public interest and environmental organizations, and the public. In October 1978 the IRG issued a draft report for public review and comment. Some 3300 comments were received and reviewed, and their final report, which was published in March 1979, reflects their consideration of these comments. This article summarizes the final report, using to the extent practical the same format, wording, and emphasis.

WASTE PROCESSING

11332 (CONF-800305—4) **Corrosion experience in calcination of liquid nuclear waste.** Zimmerman, C.A. (Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)). 1980. Contract EY-76-C-07-1570. 26p. Dep. NTIS, PC A03/MF A01.

From Corrosion/80 NACE meeting; Chicago, IL, USA (6 Mar 1980).

The Waste Calcining Facility (WCF) at the Idaho National Engineering Laboratory became operational in 1963. Since that time, approximately 13,337,137 litres (3,523,375 gallons) of liquid nuclear wastes, generated during the reprocessing of spent nuclear fuel materials, have been reduced to dry granular solids. The volume reduction is about seven or eight gallons of liquid waste to one gallon of dry granular solids. This paper covers some of the corrosion experiences encountered in over fifteen years of operating that calcination facility. 7 figures, 7 tables.

11333 (DP-MS—79-39) **Attack of high-strength, oxidation-resistant alloys during in-can melting of simulated waste glasses.** Rankin, W.N. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1980. Contract EY-76-C-09-0001. 31p. (CONF-800305—3). Dep. NTIS, PC A03/MF A01.

From Corrosion/80 NACE meeting; Chicago, IL, USA (6 Mar 1980).

The restistance of candidate canister alloys to penetration under the most severe conditions expected during in-can melting was directly proportional to the chromium content of the alloy, and inversely proportional to the Na_2O content of the glass melt. Specimens were exposed for 24 hours, which is the time required for in-can melting full-size waste-glass forms based on tests carried out at Pacific Northwest Laboratories (PNL) and at SRL. The penetration resistance to Frit 211 at 1150°C for 24 hours of most alloys tested was satisfactory. The amount of penetration would not affect the integrity of the waste form. Inconel 625, Hastelloy X, and Inconel 601 were penetrated < 20 mils. This was considered excellent. Incoloy 801, Type 310 stainless steel, Type 304L stainless steel, Inconel 600, and Type 347 stainless steel were penetrated < 40 mils. This was considered good. Hastelloy C-4 was penetrated > 100 mils by a glass composed of 65 wt % Frit 21 and 35 wt % composite sludge (with uranium) at 1150°C for only 7 hours. This amount of penetration of an in-can melting canister would not be satisfactory. 12 figures.

11334 (EGG-FM—5041) **Summary of FY 1979 material support studies for SPI - migration and immobilization.** Flinn, J.E.; Kelsey, P.V.; Seymour, W.C.; Tallman, R.L. (EG and G Idaho, Inc., Idaho Falls (USA)). Sep 1979. Contract EY-76-C-07-1570. 30p. Dep. NTIS, PC A03/MF A01.

Material studies were performed in support of the Slagging Pyrolysis Incinerator Project for characterizing the slag product expected from processing low-level waste. The studies included chemical compositional analysis of slag products from waste feed after pyrolysis, slag/refractory interactions, phase and structure of the slag, and chemical leaching. A series of slag compositions were identified using average waste feed and soil. The slags are termed iron-rich basalt vitrophyre. For the materials tests a series of uranium-doped slags were made in the laboratory. Ruby refractory was observed to be the most compatible with the slag series. Structure studies on the slags disclosed that the primary crystalline phases that develop are diopside ($CaMgSi_2O_6$) and iron oxide. Chemical leach tests performed on the slag series show evidence that the slags have a high resistance to leaching.

11335 (LA—8052-MS) **Evaluation procedure for radioactive waste treatment processes.** Whitty, W.J. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 28p. Dep. NTIS, PC A03/MF A01.

An aspect of the Los Alamos Scientific Laboratory's nuclear waste management R and D programs has been to develop an evaluation procedure for radioactive waste treatment processes. This report describes the process evaluation method. Process worth is expressed as a numerical index called the Figure-of-Merit (FOM), which is computed using a hierarchial, linear, additive, scoring model with constant criteria weights and nonlinear value functions. A numerical example is used to demonstrate the procedure and to point out some of its strengths and weaknesses. Potential modifications and extensions are discussed, and an extensive reference list is included.

11336 (MLM—2670) **Pelletized Waste Form Demonstration Program: April-September 1979.** Lewis, E.L.; Herbert, R.F. Jr. (Mound

Facility, Miamisburg, OH (USA)). 7 Dec 1979. Contract EY-76-C-04-0053. 25p. Dep. NTIS, PC A02/MF A01.

During the last half of FY-1979, feasibility studies involving hot pilot-scale experiments were conducted. Sludge from the defense cyclone incinerator system was calcined and then successfully immobilized in a Portland cement matrix. This was accomplished mainly through a designed experiment in which the effects of seven variables upon compressive strength were studied. Physical and chemical properties of the sludge were also determined. Leachability and radiolysis testing of ash/cement and sludge/cement pellets was done at Mound Facility, and offsite radiolysis tests were completed at Savannah River Laboratory. Leachability data obtained indicate that leach rates are greater at ambient temperature than at 70°C. The leach rates were very small with < 0.01% of the PuO_2 leached after 20 days. Radiolysis results from SRL indicated a very low hydrogen gas generation rate, G/sub(H_2)/, caused by radiolysis of water present in pellets. Recent irradiation tests at Mound verify these results, and pressed waste/cement pellets appear to be an excellent waste form based on low gas generation rates.

11337 (ORNL/TM—7065) **Removal of hazardous radionuclides from uranium ore and/or mill tailings. Progress report, October 1, 1978-September 30, 1979.** Scheitlin, F.M.; Bond, W.D. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 68p. Dep. NTIS, PC A04/MF A01.

The leaching of uranium ore and mill tailings to remove radium was studied. A few scouting tests were performed to obtain data on the recovery of radium, thorium, and uranium from leach liquors and on the recycle of leaching agents. Nitric acid, hydrochloric acid, ethylenediaminetetraacetic acid (EDTA), and diethylenetriaminepentaacetic acid (DTPA) were evaluated as leachants using one sample of a western US ore and two samples of tailings obtained from different uranium mills that employ the sulfuric acid leach process. Leached solids with radium contents approaching 10 pCi/g (98% radium removal) were obtained after six stages of batch, crosscurrent leaching with 3 M HNO_3 at 33% concentration of solids and a temperature of 60°C. On the basis of two-stage tests on mill tailings, 0.5 M EDTA solutions at pH values of 8.2 to 11.6 were found to be more effective, while hydrochloric acid in two- or three-stage tests was less effective than nitric acid. Solutions of 0.3 M EDTA and 0.05 M DTPA were ineffective. No important differences were observed in the leaching behavior of ore and of mill tailings derived from the same ore. The residue remaining after six stages of nitric acid leaching was relatively intractable to radium leaching with water or additional nitric acid leaching. Tests indicated that the recycle of nitric acid is chemically feasible by evaporating the leach liquors to recover unused acid and then thermally decomposing the metal salts to recover consumed acid. Radium recoveries of 99+% by carrying on barium sulfate were shown to be chemically feasible in a series of experiments with leach liquors, but processing applications would probably require methods for barium recycle and barium-radium separation. Recovery of ^{230}Th and uranium from nitrate leach liquors by tri-n-butyl phosphate extraction appears promising in initial tests.

11338 (PNL-SA—7292) **Development of multibarrier nuclear waste forms.** (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1979. Contract EY-76-C-06-1830. 14p. Dep. NTIS, PC A02/MF A01.

The multibarrier concept aims to separate the radionuclide-containing inner core material and the environment by the use of coatings and matrices. Two options were developed for the inner core of the multibarrier concept: supercalcine pellets and glass marbles. Supercalcine is a crystalline assemblage of mutually compatible, refractory, and leach-resistant solid solution phases incorporating high-level liquid waste ions. Supercalcine powder is produced by spray calcining the liquid waste stream to which Al_2O_3, CaO, SiO_2, and SrO have been added. Supercalcine pellets are produced by disc pelletizing. The amorphous supercalcine crystallizes into solid solution phases after subsequent heat treatment. Based on the multibarrier processes described, several conclusions can be made: gravity sintering and vacuum casting are both applicable methods for metal matrix encapsulation. The multibarrier concept of glass marbles encapsulated in a vacuum-cast lead alloy provides enhanced inertness at a minimum increase in technological complexity. If it were desirable to develop a crystalline multibarrier waste form, uncoated sintered supercalcine pellets would offer enhanced inertness at a much lower level of technological complexity than glaze- or CVD-coated supercalcine. The 16-inch diameter pelletizer unit has enough capacity to handle the output of a large PNL spray calciner (52.5 kg of calcine/hr) and it can form spray-calcined material into pellets with diameters of 2 mm to 20 mm having strength enough to withstand handling without significant breakage.Chemical vapor deposition coating of supercalcine should be pursued only if a very high level of inertness is required.

11339 (PNL-SA—7414) **Processes for production of alternative waste forms.** Ross, W.A.; Rusin, J.M.; McElroy, J.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1979. Contract EY-76-C-06-1830. 14p. (CONF-790204—11). Dep. NTIS, PC A02/MF A01.

From Symposium on waste management and fuel cycles 1979; Tucson, AZ, USA (28 Feb 1979).

During the past 20 years, numerous waste forms and processes have been proposed for solidification of high-level radioactive wastes (HLW). The number has increased significantly during the past 3 to 4 years. At least five factors must be considered in selecting the waste form and process method: 1) processing flexibility, 2) waste loading, 3) canister size and stability, 4) waste form inertness and stability, and 5) processing complexity. This paper describes various waste form processes and operations, and a simple system is proposed for making comparisons. This system suggests that one goal for processes would be to reduce the number of process steps, thereby providing less complex processing systems.

11340 (RHO-CD—783) **Theoretical considerations in solid bowl centrifugation.** Hamilton, R.T. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). 24 Aug 1979. Contract EY-77-C-06-1030. 25p. Dep. NTIS, PC A02/MF A01.

A combination of literature survey and independent analysis determined three relationships for the prediction of the critical (or minimum recoverable) particle size in a solid bowl centrifuge. The relationships were derived based on three different theories of fluid behavior within the centrifuge; (1) laminar film flow (laminar film model), (2) plug flow (Sharples Model), and paraboʲic flow (modified Sharples Model). The critical particle size for the centrifuge used in Cs-PTA recovery in the CAW process predicted by the three relationships range from 0.19 to 0.34 μm (1 μm = 10^{-6}m). The laminar film model gives the most conservative estimate of critical particle size (0.34 μm) and the resulting relationship is recommended for use to predict solid bowl centrifuge performance. Three correction factors are incorporated into the predictive equations to account for the effects of fluid turbulence near the centrifuge feed point, fluid lag and hindered settling. Of these factors, turbulence near the feed point (which is accounted for by using an effective centrifuge length) has the greatest impact, increasing the predicted critical particle size by 15%, while the combination of fluid lag and hindered settling factors increase the recoverable particle size by 4%. The overall effect of the correction factors is an approximately 20% decrease in centrifuge effectivity. The fraction of solids smaller than the critical size range has not been reliably determined for laboratory or plant prepared Cs-PTA. In addition, the density of Cs-PTA crystals is reported to vary from 3.2 to 12 grams per cubic centimeter.

11341 **Radioactive waste disposal.** Gablin, K.A.; Hansen, L.J. (to Nuclear Engineering Co.). US Patent 4,167,491. 11 Sep 1979. Filed date 7 Jun 1976. 8p.

A method of disposing of wet radioactive waste materials such as those generated in the water used to cool atomic reactors, comprises combining the waste material with a hydrophilic resin in proportions sufficient to provide a solid mass of the resin with the radioactive waste component distributed within. In its preferred form, the waste material is concentrated by separating water from the radioactive portions thereof by methods such as evaporation, taking up the waste components with an ion exchange resin and separating the resin from the bulk of the water, or by the addition of flocculating agents or the like and filtering. The preferred hydrophilic resinous material is a conventional urea-formaldehyde dispersion, which is partially polymerized and capable of taking up water and fully polymerizing upon the addition of an acidic curing agent. The method also contemplates adding a substantially waterproof resinous material to the surface of the solid block, or enclosing it in a waterproof container, or both.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 11366, 11369, 11370, 11371, 11372, 11373, 11374, 12480, 12511, 12531, 12697

11342 (ANL—78-81) **Feasibility of underground storage/disposal of noble gas fission products.** Winar, R.M.; Trevorrow, L.E.; Steindler, M.J. (Argonne National Lab., IL (USA)). Aug 1979. Contract W-31-109-ENG-38. 87p. Dep. NTIS, PC A05/MF A01.

The quantities of ^{85}Kr that can be released to the environment from nuclear energy production are to be limited after 1983 by Federal regulations. Although procedures for collecting the ^{85}Kr released in the nuclear fuel cycle have been developed to the point that they are commercially available, procedures for terminal disposal of the collected gas are still being examined for their feasibility. In this work, the possibilities of underground disposal of ^{85}Kr by several techniques were evaluated. It was concluded that (1) disposal of ^{85}Kr as a solution in water or other solvents in deep wells would have the major disadvantages of liquid migration and the requirement of extremely large volumes of solvent; (2) disposal as bubbles entrained in cement grout injected underground presents the uncertainty of gaseous migration through permeable solid grout; (3)

disposal by injection into abandoned oil fields would be favored by solubility of krypton in residual hydrocarbons, but has the disadvantages that such fields contain numerous shafts offering avenues of escape and also that the fields may be reworked in the future for their hydrocarbon residues; (4) underground retention of ^{85}Kr injected as a gas may be promising, given the right lithology, through entrapment in interstices between fine sand grains held together by the interfacial tension of wetted surfaces. 9 figures, 5 tables.

11343 (BNL—26455) **Strain related radiation damage measurements in rock salt for waste disposal applications. Quarterly report, April 1, 1979-June 30, 1979.** Swyler, K.J.; Teutonico, L.J.; Levy, P.W. (Brookhaven National Lab., Upton, NY (USA)). 10 Jul 1979. Contract EY-76-C-02-0016. 23p. (ONWI/Sub—78/E511-01000-8). Dep. NTIS, PC A02/MF A01.

Radiation damage in natural rock salt, synthetic NaCl crystals, and other minerals of interest for radioactive waste disposal application was studied. The following topics were covered: (1) temperature dependence of radiation induced F-center formation in rock salt from drill hole AEC-8, (2) temperature dependence of the radiation induced colloid formation in AEC-8 rock salt, (3) thermally induced colloid formation, (4) radiation induced colloid and color-center formation in different regions of non-uniformly colored crystals, (5) comment on differences in colloid formation between natural and synthetic rock salt, and (6) theoretical studies on dislocations in rock salt. (DMC)

11344 (BNL—26931) **Strain related radiation damage measurements in rock salt for waste disposal applications. Quarterly report, July 1-September 30, 1979.** Swyler, K.J.; Teutonico, L.J.; Levy, P.W. (Brookhaven National Lab., Upton, NY (USA)). 10 Oct 1979. Contract EY-76-C-02-0016. 26p. (ONWI/Sub—78/E511-01000-11). Dep. NTIS, PC A03/MF A01.

Radiation damage in natural rock salt, synthetic NaCl crystals, and other minerals of interest for radioactive waste disposal application was studied. The following topics were covered: (1) the role of strain applied prior to irradiation on the radiation-induced defect formation in natural rock salt from Drill Hole AEC-8, (2) studies to determine why synthetic and natural rock salt exhibit different radiation damage characteristics, (3) new yield point measurements on Alt Aussee natural rock salt, and (4) theoretical studies on the role of dislocations in the nucleation of colloidal sodium particles in the irradiated rock salt. (DC)

11345 (DP-MS—79-20) **Migration of transuranic nuclides in earthen burial trenches at the Savannah River Plant.** Johnson, D.R.; Wilhite, E.L. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1979. Contract EY-76-C-09-0001. 37p. Dep. NTIS, PC A03/MF A01.

The objectives, incentives and benefits derived from the data collected at the Savannah River Laboratory on waste migration were discussed, and encapsulated transmission waste burial data were presented. Factors influencing radionuclide migration were characterized. A map of the burial ground was included. The trench sampling strategy was summarized. A description of the coring samples was included. Actual soil recovery results were tabulated, and a specific problem which reduced recoveries even when using a Shelby tube core was discussed. Data on waste strike distribution and activity as a function of depth were tabulated. The composition of recovered waste was tabulated. Wood and paper were well preserved in spite of long burial. Radiation of core samples was measured. The distribution of plutonium among soil particle sizes was determined.

11346 (IDO—10085) **Environmental and other evaluations of alternatives for long-term management of buried INEL transuranic waste.** (Idaho National Engineering Lab., Idaho Falls (USA)). Dec 1979. Contract EY-76-C-07-1570. 527p. Dep. NTIS, PC A23/MF A01.

This study identifies, develops, and evaluates, in a preliminary manner, alternatives for long-term management of the TRU waste buried at the RWMC at the INEL. The technology required for managing the waste, the environmental effects, the risks to the public, the radiological and nonradiological hazards to workers, and the estimated costs are discussed. The RWMC was established in the southwestern corner of the INEL in 1952 as a controlled area for burial of solid radioactive waste generated by INEL operations. It encompasses about 144 acres. Since 1954, solid waste contaminated with transuranic radionuclides has been received from defense-related activities at the RFP and from other operations of the AEC and its successor agencies. Approximately 2,200,000 ft^3 of TRU waste was buried in pits and trenches at the RWMC between 1954 and 1970. Since 1970, about 1,100,000 ft^3 of TRU waste has been received and stored retrievably on aboveground asphalt pads at the RWMC. The containers (metal bins and drums and wooden boxes) for the stored waste are generally in good condition. However, the containers for the buried waste have deteriorated badly; some of the waste, such as large pieces of equipment, was buried without containers. Some of the soil immediately adjacent to the buried waste has become contaminated. Six alternatives for the long-term management of the buried TRU waste were studied. These alternatives are identified and concepts within these alternatives developed and evaluated.

11347 (LBL—9426) **Experimental results from Stripa.** Hood, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1979. Contract W-7405-ENG-48. 18p. (CONF-790683—3). Dep. NTIS, PC A02/MF A01.

From ONWI-LLL workshop on thermomechanical modeling for a hard rock repository; Berkeley, CA, USA (25 Jun 1979).

The results indicate that the temperature fields in a rock mass containing geologic discontinuities can be predicted accurately using the simple theory of heat conduction. Geologic discontinuities appear to introduce significant nonlinear thermomechanical deformation into the rock mass, as a result of which the thermally induced displacements are much less than those predicted by the simple theory of thermo-elasticity. In addition, the assumption that the rock properties are temperature independent appears to increase the values predicted for these displacements significantly. Therefore, it is important that the temperature dependence of these properties is known and that these values be used in the calculations. The onset of significant thermal spalling along the walls of the heater boreholes appears to be related to conditions where the maximum induced compressive stress exceeds the uniaxial compressive strength of the rock. 7 figures.

11348 (NVO—196-12) **Nevada nuclear waste storage investigations. Quarterly report, July-September 1979.** (Department of Energy, Las Vegas, NV (USA). Nevada Operations Office). Dec 1979. 62p. Dep. NTIS, PC A04/MF A01.

Geohydrologic cross sections through the Kern Mountains, Lone Mountain-Weepah Hills, and Clipper Gap granitic areas indicate that the groundwater flow paths from the Kern Mountains are the longest and those from Clipper Gap the shortest. Probability of both the recurrence of volcanism and the disruption of a repository site at Yucca Mountain fall in the range of 10^{-9} per year. Global thermomechanical calculations of the response of agrillite to thermal expansion have been completed. A study of Spent Fuel Test-Climax showed that radiation exposure would not induce sufficient hydrogen production to create an explosive mixture during the five-year experiment - even without any ventilation.

11349 (ONWI—79/E511-00300-4) **Locating field confirmation study areas for isolation of nuclear waste in the Texas Panhandle. Annual report, October 1, 1978-September 30, 1979.** Gustavson, T.C.; Handford, C.R.; Presley, M.W.; Baumgardner, R.W. Jr.; Dutton, S.P.; Finley, R.J.; McGillis, K.A.; Simpkins, W.W. (Texas Univ., Austin (USA). Bureau of Economic Geology). 1 Dec 1979. Contract AC97-79ET44614. 115p. Dep. NTIS, PC A06/MF A01.

Since early 1977, the Bureau of Economic Geology has been evaluating several salt-bearing basins within the State of Texas as part of the national nuclear repository program. The Bureau, a research unit of the University of Texas at Austin and the State of Texas, is carrying out a long-term program to gather and interpret all geologic and hydrologic information necessary for description, delineation, and evaluation of salt-bearing strata in the Palo Duro and Dalhart Basins of the Texas Panhandle. The program in FY 79 has been subdivided into four broad research tasks, which are addressed by a basin analysis group, a surface studies group, a geohydrology group, and a host-rock analysis group. The basin analysis group has delineated the structural and stratigraphic framework of the basins, initiated natural resource assessment, and integrated data from 8000 ft (2400 m) of core material into salt-stratigraphy models. Salt depth and thickness have been delineated for seven salt-bearing stratigraphic units. Concurrently, the surface studies group has collected ground and remotely sensed data to describe surficial processes, including salt solution, slope retreat/erosion mechanisms, geomorphic evolution, and fracture system development. The basin geohydrology group has begun evaluating both shallow and deep fluid circulation within the basins. The newly formed host-rock analysis group has initiated study of cores from two drilling sites for analysis of salt and the various lithologies overlying and interbedded with salt units. This paper, a summary report of progress in FY 79, presents principal conclusions and reviews methods used and types of data and maps generated. Topical reports, discussing various geological aspects of the Palo Duro and Dalhart Basins in detail, will be forthcoming as phases of the study are completed.

11350 (ORNL/CSD/TM—84) **Diffusion from solid cylinders.** Nestor, C.W. Jr. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 31p. Dep. NTIS, PC A03/MF A01.

The problem considered is the diffusion of material from a solid cylinder initially containng a uniform concentration and immersed in a well-stirred bath which maintains the external concentration at zero. The Fourier-Bessel series form of the fraction of the original material removed from the cylinder as a function of time converges very slowly for small time. An alternate form was ob-

tained, which converges reasonably rapidly for small time. The convergence acceleration method of P. Wynn was also used to provide an efficient method for computation. Numerical examples and program listings are included.

11351 (ORNL/TM—7092) **Cement technology for borehole plugging: an interim report on permeability measurements of cementitious solids.** McDaniel, E.W. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 25p. Dep. NTIS, PC A02/MF A01.

The permeability of borehole plug solids and plug-wall rock junctions is a property of major interest in the Borehole Plugging Program. This report describes the equipment and techniques used to determine the permeabilities of possible borehole plugging materials and presents results from tests on various cementitious solids and plug-rock combinations. The cementitious solids were made from mixtures of cement, sand, salt, fly ash, and water. Three different types of cement and four different fly ashes were used. Permeabilities ranged from a high value of 3×10^{-4} darcy for a neat cement paste to a low of 5×10^{-8} darcy for a saltcrete containing 30 wt % sodium chloride. Miniature boreholes were made in the following four different types of rock: Westerly granite, Dresser basalt, Sioux quartzite, and St. Cloud granodiorite. These small holes were plugged with a mix consisting of 23 wt % Type I Portland cement, 20 wt % bituminous fy ash, 43.2 wt % sand, and 13.8 wt % water. After curing for 91 days at ambient temperature, the permeability of the plug-wall rock junctions ranged from 3×10^{-5} to $< 1 \times 10^{-8}$ darcy. Three of the four miniature plugged boreholes exhibited permeabilities of < 10 microdarcys.

11352 (PNL—2851) **Summary of FY-1978 consultant input for scenario methodology development.** Scott, B.L.; Benson, G.L.; Craig, R.A. (eds.); Harwell, M.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Nov 1979. Contract EY-76-C-06-1830. 180p. Dep. NTIS, PC A04/MF A01.

Associated with commercial nuclear power production in the United States is the generation of potentially hazardous radioactive waste products. The Department of Energy (DOE), through the National Waste Terminal Storage (NWTS) Program, is seeking to develop nuclear waste isolation systems in geologic formations. These underground waste isolation systems will preclude contact with the biosphere of waste radionuclides in concentrations which are sufficient to cause deleterious impact on humans or their environments. Comprehensive analyses of specific isolation systems are needed to assess the postclosure expectations of the systems. Assessment of Effectiveness of Geologic Isolation Systems (AEGIS) program has been established for developing the capability of making those analyses. The assessment of repository post-closure safety has two basic components: identification and analyses of breach scenarios and the pattern of events and processes causing each breach, and identification and analyses of the environmental consequences of radionuclide transport and interactions subsequent to a repository breach. Specific processes and events which might affect potential repository sites and, the rates and probabilities for those phenomena are presented. The description of the system interactions and synergisms and of the repository system as an evolving and continuing process are included. Much of the preliminary information derived from the FY-1978 research effort is summarized in this document. This summary report contains information pertaining to the following areas of study: climatology, geomorphology, glaciology, hydrology, meteorites, sea level fluctuations, structural geology and volcanology.

11353 (PNL—3227) **Geophysical surveys for buried waste detection at the Idaho National Engineering Laboratory.** Sandness, G.A.; Rising, J.L.; Kimbrough, J.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Dec 1979. Contract EY-76-C-06-1830. 77p. Dep. NTIS, PC A05/MF A01.

This report describes a series of geophysical surveys performed at the Idaho National Engineering Laboratory (INEL). The main purpose of the surveys was to evaluate techniques, principally ground-penetrating radar, for detecting and mapping radioactive wastes buried in shallow trenches and pits. A second purpose was to determine the feasibility of using ground-penetrating radar to measure the depth of basalt bedrock. A prototype geophyscal survey system developed by the US Department of Energy's Pacific Northwest Laboratory was used for this study. Radar, magnetometer, and metal detector measurements were made at three sites in the Radioactive Waste Management Complex (RWMC) at INEL. Radar measurements were made at fourth site adjacent to the RWMC. The combination of three geophysical methods was shown to provide considerable information about the distribution of buried waste materials. The tests confirmed the potential effectiveness of the radar method, but they also pointed out the need for continued research and development in ground-penetrating radar technology. The radar system tested in this study appears to be capable of measuring the depth to basalt in the vicinity of the RWMC.

11354 (PNL-SA—7243) **Waste isolation safety assessment program.** Brandstetter, A.; Harwell, M.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1979. Contract EY-76-C-06-1830. 15p. (IAEA-SM—243/35; CONF-790711—4). Dep. NTIS, PC A02/MF A01.

From International symposium on underground disposal of radioactive wastes; Otaniemi, Finland (2 Jul 1979).

Associated with commercial nuclear power production in the United States is the generation of potentially hazardous radioactive wastes. The Department of Energy (DOE), through the National Waste Terminal Storage (NWTS) Program, is seeking to develop nuclear waste isolation systems in geologic formations that will preclude contact with the biosphere of waste radionuclides in concentrations which are sufficient to cause deleterious impact on humans or their environments. Comprehensive analyses of specific isolation systems are needed to assess the expectations of meeting that objective. The Waste Isolation Safety Assessment Program (WISAP) has been established at the Pacific Northwest Laboratory (operated by Battelle Memorial Institute) for developing the capability of making those analyses. Among the analyses required for isolation system evaluation is the detailed assessment of the postclosure performance of nuclear waste repositories in geologic formations. This assessment is essential, since it is concerned with aspects of the nuclear power program which previously have not been addressed. Specifically, the nature of the isolation systems (e.g., involving breach scenarios and transport through the geosphere), and the time-scales necessary for isolation, dictate the development, demonstration and application of novel assessment capabilities. The assessment methodology needs to be thorough, flexible, objective, and scientifically defensible. Further, the data utilized must be accurate, documented, reproducible, and based on sound scientific principles.

11355 (SAND—79-1305) **Summary of research and development activities in support of waste acceptance criteria for WIPP.** Hunter, T.O. (comp.). (Sandia Labs., Albuquerque, NM (USA)). Nov 1979. Contract EY-76-C-04-0789. 244p. Dep. NTIS, PC A11/MF A01.

The development of waste acceptance criteria for the Waste Isolation Pilot Plant (WIPP) is summarized. Specifications for acceptable waste forms are included. Nine program areas are discussed. They are: TRU characterization, HLW interactions, thermal/structural interactions, nuclide migration, permeability, brine migration, borehole plugging, operation/design support, and instrumentation development. Recommendations are included. (DC)

11356 (SAND—79-2023C) **Titanium alloy corrosion in nuclear waste environments.** Braithwaite, J.W.; Magnani, N.J.; Munford, J.W. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 35p. (CONF-800305—5). Dep. NTIS, PC A03/MF A01.

From Corrosion/80 NACE meeting; Chicago, IL, USA (6 Mar 1980).

A corrosion study has been conducted on the titanium alloys Ti-50A, TiCode 12, and Ti-Pd to evaluate their suitability as a long lifetime (300 to 600 year) canister material for the isolation of nuclear wastes. TiCode 12, selected as the primary candidate material, is shown to be very resistant to environmental attack. Results of electrochemical, general corrosion, and stress corrosion cracking experiments are presented. These data, including those from severe overtests, have shown that TiCode 12 is a viable candidate material for long-term waste isolation. 17 figures.

11357 (SAND—80-0007/2) **Subseabed Disposal Program Plan. Volume II. FY80 budget and subtask work plans.** (Sandia Labs., Albuquerque, NM (USA)). Jan 1980. Contract EY-76-C-04-0789. 63p. Dep. NTIS, PC A04/MF A01.

This volume of the Subseabed Disposal Program Plan presents a breakdown of the master program structure by major activity. Each activity is described and accompanied by a specific cost plan schedule and a milestone plan. The costs have been compiled in the Cost Plan Schedules attached to each Subtask Work Plan. The FY 1980 budget for the Subseabed Disposal Program is summarized at the second level of the Work Breakdown Structure. The milestone plans for FY 80 are presented. The milestones can be changed only with the concurrence of the Sandia Subseabed Program Manager.

11358 (UCRL—15152) **Geoscience parameter data base handbook: granites and basalts.** (Owens (Willard) Associates, Inc., Wheat Ridge, CO (USA)). Dec 1979. Contract W-7405-ENG-48. 407p. Dep. NTIS, PC A18/MF A01.

The Department of Energy has the responsibility for selecting and constructing Federal repositories for radioactive waste. The Nuclear Regulatory Commission must license such repositories prior to construction. The basic requirement in the geologic disposal of radioactive waste is stated as: placement in a geologic host whereby the radioactive waste is not in mechanical, thermal or chemical equilibrium with the object of preventing physical or chemical migration of radionuclides into the biosphere or hydrosphere in

hazardous concentration (USGS, 1977). The object of this report is to document the known geologic parameters of large granite and basalt occurrences in the coterminous United States, for future evaluation in the selection and licensing of radioactive waste repositories. The description of the characteristics of certain potential igneous hosts has been limited to existing data pertaining to the general geologic character, geomechanics, and hydrology of identified occurrences. A description of the geochemistry is the subject of a separate report.

11359 (UCRL—15166(Vol.1)) **Derivation of parameters necessary for the evaluation of performance of sites for deep geological repositories with particular reference to bedded salt, Livermore, California. Volume I. Main text.** Ashby, J.P.; Rawlings, G.E.; Soto, C.A.; Wood, D.F.; Chorley, D.W. (Golder Associates, Inc., Kirkland, WA (USA)). Dec 1979. Contract W-7405-ENG-48. 289p. Dep. NTIS, PC A13/MF A01.

A survey of parameters to be considered in the evaluation of sites for deep geologic nuclear waste repositories is presented. As yet, no comprehensive site selection procedure or performance evaluation approach has been adopted. A basis is provided for the development of parameters by discussing both site selection and performance evaluation. Three major groups of parameters are considered in this report: geologic, mining/rock mechanics, and hydrogeologic. For each type, the role of the parameter in the evaluation of repository sites is discussed. The derivation of the parameter by measurement, correlation, inference, or other method is discussed. Geologic parameters define the framework of the repository site and can be used in development of conceptual models and the prediction of long-term performance. Methods for deriving geological parameters include mapping, surveying, drilling, geophysical investigation, and historical and regional analysis. Rock mechanics/mining parameters are essential for the prediction of short-term performance and the development of initial conditions for modeling of long-term performance. Rock mechanics/mapping parameters can be derived by field or laboratory investigation, correlation, and theoretically or empirically based inference. Hydrogeologic parameters are the most important for assessment of long-term radionuclide confinement, since transport throughout the regional hydrogeologic system is the most likely mode of radionuclide escape from geologic repositories. Hydrogeologic parameters can be derived by hydrogeologic mapping and interpretation, hydrogeologic system modeling, field measurements, and lab tests. Procedures used in determination and statistical evaluation of geologic and rock mechanics parameters are discussed.

11360 (UCRL—15166(Vol.2)) **Derivation of parameters necessary for the evaluation of performance of sites for deep geological repositories with particular reference to bedded salt, Livermore, California. Volume II. Appendices.** Ashby, J.P.; Rawlings, G.E.; Soto, C.A.; Wood, D.F.; Chorley, D.W. (Golder Associates, Inc., Kirkland, WA (USA)). Dec 1979. Contract W-7405-ENG-48. 173p. Dep. NTIS, PC A08/MF A01.

The method of selection of parameters to be considered in the selection of a site for underground disposal of radioactive wastes is reported in volume 1. This volume contains the appendix to that report. The topics include: specific rock mechanics tests; drilling investigation techniques and equipment; geophysical surveying; theoretical study of a well text in a nonhomogeneous aquifer; and basic statistical and probability theory that may be used in the derivation of input parameters.

11361 (UCRL—15167(Vol.1)) **Aspects of nuclear waste management. Volume 1. Pre-emplacement risks.** Ensminger, D.A.; Oston, S.G. (Analytic Sciences Corp., Reading, MA (USA)). 10 Aug 1979. Contract W-7405-ENG-48. 58p. Dep. NTIS, PC A04/MF A01.

Results of the previous one-dimensional thermal analysis of interim storage accidents are confirmed by more detailed two-dimensional calculations. Waste temperatures calculated for interim storage accidents are moderately sensitive to assumptions concerning canister spacing and are much less sensitive to boundary conditions at the canister top. For an individual 100 m from a transportation accident involving solidified high-level waste, the expected dose from gamma radiation is on the order of or smaller than the other possible exposures in the same accident. For the calculation of expected doses to the worst-situated individual in accidents: Expected population dose should remain the primary measure of pre-emplacement risk in order to maintain comparability of consequences of different types of accidents.

11362 (USGS—1543-4) **Geohydrology of hole UE-17a, Syncline Ridge area, Nevada Test Site.** Weir, J.E. Jr.; Hodson, J.N. (Geological Survey, Denver, CO (USA)). Dec 1979. Contract EW-78-I-08-1543. 23p. Dep. NTIS, PC A02/MF A01.

Hole UE-17a was drilled as part of a study to evaluate the suitability of Unit J of the Eleana Formation of Mississippian age as a medium for storage of nuclear wastes. The 1214-foot (370-meter) hole penetrated alluvium of Quaternary age, a thrust plate of the Tippipah Limestone of Pennsylvania and Permian age, and 668 feet (204 meters) of the Eleana Formation. A small amount of groundwater occurs in fractured quartzites and limestones of the Eleana Formation; jetting produced only 20 gallons per minute (1.3 liters per second) from the completed hole. Approximate transmissivity, calculated from jetting test results, is 1.2 feet squared per day (0.11 meters squared per day). The hydraulic head has almost steadily declined in the hole since September 29, 1976, a few days after the hole was completed. Water from the Eleana Formation is a sodium bicarbonate and sodium sulfate type.

11363 (ANL-Trans—1181) **Handling high-level radioactive wastes.** Heimerl, W. Translated from *Chem. Unserer Zeit;* **12**: No. 3, 82-88(1978). 21p. Dep. NTIS, PC A02/MF A01.

High-activity waste (HAW) solutions which result from the reprocessing of irradiated reactor fuels is a problem because of the long-lived radioactivity. Tank storage is only an intermediate solution. Solidification of HAW solutions is a better solution, particularly vitrification. The German PAMELA process is described in detail; it involves producing the glass in the form of beads in a heavy metal matrix. Plans to store the solidified HAW in salt domes are discussed. From the technical standpoint, a large facility can be built by the 1990's for disposing of the waste from an industrial reprocessing plant. 9 figures, 2 tables. (DLC)

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 11330, 11345, 11352, 11354, 11355, 12475, 12476, 12510, 12511, 12513, 12548, 12549, 12625, 12638

11364 (ANL/ES—79) **Environmental analysis of a formerly utilized MED/AEC site: Site A and plot M, Palos Forest Preserve, Palos Park, Illinois.** (Argonne National Lab., IL (USA)). Sep 1979. Contract W-31-109-ENG-38. 107p. Dep. NTIS, PC A06/MF A01.

This environmental analysis report describes the existing site environment and evaluates the environmental impacts of 8 options for remedial action, including allowing buried waste to remain undisturbed. Conformity or conflict with governmental statutes, regulations and standards was determined, especially with regard to compliance with contamination criteria and guidelines. The program of measurements, documentation, and control to demonstrate compliance with these criteria and guidelines was identified.

11365 (DOE/EV—0005/17) **Formerly utilized MED/AEC sites remedial action program: radiological survey of the former Simonds Saw and Steel Co., Lockport, New York. Final report.** (Oak Ridge National Lab., TN (USA)). Nov 1979. Contract W-7405-ENG-26. 86p. Dep. NTIS, PC A05/MF A01.

Results of a radiological survey of the former Simonds Saw and Steel Company (current name of this facility is Guterl Special Steel Corporation), Lockport, New York, are presented in this report. During the period 1948 to 1956, this company handled large quantities of uranium metal and smaller quantities of thorium metal in rolling mill operations. The survey included measurement of residual alpha and beta-gamma radiation levels in the rolling mill building and forging shop; external gamma radiation in the same area; uranium, radium, and thorium in soil samples taken from beneath removable floor plates in the rolling mill area and from other parts of the site; radon and radon daughter concentrations in the rolling mill building; and contamination in drainage paths leading from the buildings and grounds. Elevated concentrations of uranium were found in soil samples taken from beneath the floor plates within 40 ft of the 16-inch rolling mill. Beta-gamma radiation levels were greater than 1 mrad/hr at the locations having the highest concentrations of uranium. External gamma radiation levels were above the background level in a few small isolated areas in the rolling mill building. The 16-inch rolling mill showed elevated alpha and beta contamination levels in several areas.

11366 (DOE/EV—0060) **Annual status report on the inactive uranium mill tailings sites remedial action program.** (Department of Energy, Washington, DC (USA). Div. of Environmental Control Technology). Dec 1979. 202p. Dep. NTIS, PC A10/MF A01.

Assessments of inactive uranium mill tailings sites in the United States led to the designation of 25 processing sites for remedial action under the provisions of Section 102(a) Public Law 95-604. The Department of Energy assessed the potential health effects to the public from the residual radioactive materials on or near the 25 sites; and, with the advice of the Environmental Protection Agency, the Secretary established priorities for performing remedial action. In designating the 25 sites and establishing the priorities for performing remedial action, the Department of Energy consulted with the Environmental Protection Agency, Nuclear Regulatory Commission, Department of the Interior, governors of the affected States, Navajo Nation, and appropriate property owners. Public participation in this process was encouraged. During Fiscal Year 1980, Department of Energy will be conducting surveys to verify the radiological characterization at the designated processing

sites; developing cooperative agreements with the affected States; and initiating the appropriate National Environmental Policy Act documentation prior to conducting specific remedial actions.

11367 (GJBX—7(80)) **Comparative study on the impact of coal and uranium mining, processing, and transportation in the western United States.** Sandquist, G.M. (Utah Univ., Salt Lake City (USA). Dept. of Mechanical and Industrial Engineering). Jun 1979. Contract EY-76-C-13-1664. 150p. Dep. NTIS, PC A07/MF A01.

A comparative study and quantitative assessment of the impacts, costs and benefits associated with the mining, processing and transportation of coal and uranium within the western states, specifically Arizona, California, Colorado, Montana, New Mexico, Oregon, Utah, Washington and Wyoming are presented. The western states possess 49% of the US reserve coal base, 67% of the total identified reserves and 82% of the hypothetical reserves. Western coal production has increased at an average annual rate of about 22% since 1970 and should become the major US coal supplier in the 1980's. The Colorado Plateau (in Arizona, Colorado, New Mexico and Utah) and the Wyoming Basin areas account for 72% of the \$15/lb U_3O_8 resources, 76% of the \$30/lb, and 75% of the \$50/lb resources. It is apparent that the West will serve as the major supplier of domestic US coal and uranium fuels for at least the next several decades. Impacts considered are: environmental impacts, (land, water, air quality); health effects of coal and uranium mining, processing, and transportation; risks from transportation accidents; radiological impact of coal and uranium mining; social and economic impacts; and aesthetic impacts (land, air, noise, water, biota, and man-made objects). Economic benefits are discussed.

11368 (HEDL-TME—79-36) **AFCT/TFCT Environmental Assessment Program: waterborne radionuclide concentration and dose calculations for the southeast study basin.** Sonnichsen, J.C. Jr.; Fletcher, J.F.; Carlson, H.A.; Charles, P.D.; Uhler, L.M. (Hanford Engineering Development Lab., Richland, WA (USA)). Nov 1979. Contract EY-76-C-14-2170. 141p. Dep. NTIS PC E04/MF E04.

In support of the Alternate Fuel Cycle Technology - Thorium Fuel Cycle Technology (AFCT/TFCT) Environmental Assessment Program, a methodology was developed and applied for purposes of estimating the radiological impact associated with the transport of waterborne radionuclides. Radionuclide concentration and ingestion dose calculations were performed for a hypothetical source located on the Savannah River Project. A study area of approximately 52,000 square miles was divided into subareas using the eight-digit water resources cataloging unit. A hydrologic model of five major river drainage basins (Santee, Edisto, Savannah, Ogeechee, and Altamaha) was prepared. One- and fifty-year individual and population dose calculations were performed.

11369 (ORNL—5447) **Assessment of the radiological impact of the inactive uranium-mill tailings at Shiprock, New Mexico.** Haywood, F.F.; Goldsmith, W.A.; Lantz, P.M.; Fox, W.F.; Shinpaugh, W.H.; Hubbard, H.M. Jr. (Oak Ridge National Lab., TN (USA)). Dec 1979. Contract W-7405-ENG-26. 94p. Dep. NTIS, PC A05/MF A01.

Uranium-mill tailings at an inactive site near Shiprock, New Mexico, contain an estimated 950 curies (Ci) of ^{226}Ra together with its radioactive daughters. A radiological survey was conducted at this site in February 1976. Decontamination work and tailings stabilization performed at the site since that time have greatly changed conditions there and little effort was applied to quantification of potential health effects in comparison to the earlier consideration of the site at Salt Lake City. The present report delineates the radiological conditions that existed at the time of the survey including information on the surface and below-surface distribution of ^{226}Ra. The data presented support the conclusion that diffusion of radon and inhalation of radon daughters is the principal mode of exposure of offsite population groups.

11370 (ORNL—5449) **Assessment of the radiological impact of the inactive uranium-mill tailings at Monument Valley, Arizona.** Haywood, F.F.; Goldsmith, W.A.; Hubbard, H.M. Jr.; Fox, W.F.; Shinpaugh, W.H. (Oak Ridge National Lab., TN (USA)). Dec 1979. Contract W-7405-ENG-26. 74p. Dep. NTIS, PC A04/MF A01.

Results of a radiological survey that was conducted at the inactive uranium-mill site at Monument Valley, Arizona, in March 1976, in cooperation with a team from Ford, Bacon and Davis Utah Inc., are presented. Consideration of these data and of previously published information on radiological conditions at the site lead to the conclusion that potential health effects from exposure to radionuclides in the mill tailings are relatively small. The occupants of three residences within 0.8 km (0.5 mile) of the tailings constitute the principal population at risk, but direct gamma-exposure rate measurements near the two residences closest to the tailings and calculations of radon dispersion indicate that the tailings do not raise either pathway of radiation exposure significantly above the background level. Data are not available to evaluate fully other possible exposure pathways, but the available information indicates that it is unlikely that doses through these pathways will add significantly to the total population dose. The low estimates of potential health effects from exposure to direct radiation and to exposure to radionuclides in the Monument Valley tailings piles are ascribed to the low ^{226}Ra inventory, to almost complete absence of small particles that are readily moved by wind and water, and to a small population in the vicinity of the tailings.

11371 (PNL—2970) **GETOUT: a computer program for predicting radionuclide decay chain transport through geologic media.** DeMier, W.V.; Cloninger, M.O.; Burkholder, H.C.; Liddell, P.J. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1979. Contract EY-76-C-06-1830. 342p. Dep. NTIS, PC A15/MF A01.

A guide to the use of the GETOUT code is presented. The code models the migration of radionuclides from an underground source to a surface body of water. Output from the code comprises: (1) a nuclide discharge summary file in a format suitable for input to an existing biosphere model, and (2) printed reports showing discharge profiles for selected nuclides by four release modes. The guide provides a general description of the GETOUT system, program listings, sample output, and instructions, with examples for executing the code.

11372 (PNL-SA—7468) **Workshop on transport modeling for nuclear waste repositories.** Raymond, J.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jul 1977. Contract EY-76-C-06-1830. 18p. Dep. NTIS, PC A02/MF A01.

The Transport Modeling task includes developing methods to describe the transport and impact of radiocontaminants accidentally released from waste repositories; demonstrating the use of these methods; and making the methods and techniques available to the repository managers for application at specific sites. The workshop on Transfer Modeling for the Waste Isolation Safety Assessment Program was held at the Battelle Seattle Research Center on 25 and 26 July 1977. The objectives of the workshop were to: 1) discuss needs and criteria for the models, 2) obtain critiques of proposed model systems from experts in the field, and 3) obtain ideas for making models more useful to the safety assessment program. The proceedings of the workshop were presented.

11373 (SAND—79-1665C) **Thermal conductivity of rocksalt and other geologic materials from the site of the proposed waste isolation pilot plant.** Sweet, J.N.; McCreight, J.E. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 25p. (CONF-791134—7). Dep. NTIS, PC A02/MF A01.

From 16. international thermal conductivity conference; Chicago, IL, USA (7 Nov 1979).

The measurements first reported by Acton on the thermal conductivity of samples taken from a borehole at the site of the proposed nuclear waste isolation pilot plant (WIPP) near Carlsbad, NM, have been extended to include additional samples and higher temperature measurements. Samples for our measurements were taken from several depths of three wells, including the well AEC 8 from which Acton obtained his samples. These samples ranged from relatively pure rocksalt (NaCl) with small amounts of interstitial anhydrite to essentially nonsalt samples composed of gypsum or clay. The measurements in this latest series were conducted at Sandia using the longitudinal heat flow apparatus described by Acton, at the Los Alamos Scientific Laboratory (LASL) using a transient line source technique, and at Dynatech Corp., Cambridge, MA using a linear heat flow comparative technique. On the basis of these experiments, we have concluded that the thermal conductivity of materials found at the site can be predicted to an accuracy ~ +- 30% from knowledge of the composition and grain size of these materials.

11374 (UCRL—15150) **NUTRAN: a computer model of long-term hazards from waste repositories.** Ross, B.; Koplik, C.M.; Giuffre, M.S.; Hodgin, S.P.; Duffy, J.J. (Analytic Sciences Corp., Reading, MA (USA)). 7 Dec 1979. Contract W-7405-ENG-48. 118p. (TR—1797-7). Dep. NTIS, PC A06/MF A01.

The NUTRAN package of computer programs calculates doses to humans from radioactivity carried out of deep geologic waste repositories by groundwater. It consists of four codes: ORIGEN (developed by Oak Ridge National Laboratory), which treats the formation and decay of radionuclides, WASTE, which computes the transport of radionuclides in ground water, BIODOSE, which calculates radionuclide transport in surface waters and ecosystems and human exposures, and WPPLOT, which combines the results of WASTE and BIODOSE into usefully formatted outputs. This report describes what the WASTE, BIODOSE, and WPPLOT codes do. The equations they compute are presented in detail and their meaning is explained. Auxiliary programs which facilitate input and data management operations are also described.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 11322, 11324, 11368, 11374, 12146, 12479

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 11324, 12386

11375 (DOE/NE—0001(Exec.Summ.)) **Nuclear proliferation and civilian nuclear power: report of the Nonproliferation Alternative Systems Assessment Program. Executive summary.** (Department of Energy, Washington, DC (USA)). Dec 1979. 42p. Dep. NTIS, PC A03/MF A01.

The Nonproliferation Alternative Systems Assessment Program (NASAP) assessed alternative nuclear systems to find those with the lowest proliferation risk. The findings of the NASAP studies are: current and future nuclear-power systems can be made more proliferation-resistant. As long as doubts about security and fuel supply remain, more resource-efficient (and potentially less proliferation-resistant) systems will be attractive to some nations. Under some scenarios, domestic uranium supply/demand imbalances are possible beyond the year 2010. The worldwide uranium supply/demand balance is even less certain than the domestic picture. Other nuclear resources are less of a problem than uranium. Doubts about fuel supply can be alleviated in several ways. The approaches available to provide security of supply fall into three categories: resource extenders; supply improvements; and institutional and technical measures. Resource extension options include improvements to once-through cycles, advanced converters, recycle, and breeder reactors. The most promising resource extension options are light water reactor improvements (including reduced enrichment tails assay) and continued development of the plutonium-fueled breeder reactors. Uranium-supply initiatives include measures to reduce uncertainty in the estimated size of the resource base, to exploit it efficiently, and to ensure equitable access. An international nonproliferation regime will require institutional measures and technical approaches.

11376 (DOE/NE—0001(Vol.1)) **Nuclear proliferation and civilian nuclear power: report of the Nonproliferation Alternative Systems Assessment Program. Volume I. Program summary.** (Department of Energy, Washington, DC (USA)). Dec 1979. 170p. Dep. NTIS, PC A08/MF A01.

This report summarizes the Nonproliferation Alternative Systems Assessment Program (NASAP): its background, its studies, and its results. This introductory chapter traces the growth of the issue of nuclear weapons proliferation and the organization and objectives of NASAP. Chapter 2 summarizes the program's assessments, findings and recommendations. Each of Volumes II-VII reports on an individual assessment (Volume II: Proliferation Resistance; Volume III: Resources and Fuel Cycle Facilities; Volume IV: Commercial Potential; Volume V: Economics and Systems Analysis; Volume VI: Safety and Environmental Considerations for Licensing; Volume VII: International Perspectives). Volume VIII (Advanced Concepts) presents a combined assessment of several less fully developed concepts, and Volume IX (Reactor and Fuel Cycle Descriptions) provides detailed descriptions of the reactor and fuel-cycle systems studied by NASAP.

11377 (DOE/NE—0001(Vol.2)) **Nuclear proliferation and civilian nuclear power: report of the Nonproliferation Alternative Systems Assessment Program. Volume II. Proliferation resistance.** (Department of Energy, Washington, DC (USA)). Dec 1979. 192p. Dep. NTIS, PC A09/MF A01.

Volume II assesses proliferation resistance. Chapters are devoted to: assessment of civilian nuclear systems (once-through fuel-cycle systems, closed fuel cycle systems, research reactors and critical facilities); assessment of associated sensitive materials and facilities (enrichment, problems with storage of spent fuel and plutonium content, and reprocessing and refabrication facilities); and safeguards for alternative fuel cycles.

11378 (DOE/NE—0001(Vol.3)) **Nuclear proliferation and civilian nuclear power: report of the Nonproliferation Alternative Systems Assessment Program. Volume III. Resources and fuel cycle facilities.** (Department of Energy, Washington, DC (USA)). Dec 1979. 195p. Dep. NTIS, PC A09/MF A01.

Volume III explores resources and fuel cycle facilities. Chapters are devoted to: estimates of US uranium resources and supply; comparison of US uranium demands with US production capability forecasts; estimates of foreign uranium resources and supply; comparison of foreign uranium demands with foreign production capability forecasts; and world supply and demand for other resources and fuel cycle services. An appendix gives uranium, fissile material, and separative work requirements for selected reactors and fuel cycles.

11379 (DOE/NE—0001(Vol.4)) **Nuclear proliferation and civilian nuclear power: report of the Nonproliferation Alternative Systems Assessment Program. Volume IV. Commercial potential.** (Department of Energy, Washington, DC (USA)). Dec 1979. 311p. Dep. NTIS, PC A14/MF A01.

Volume IV provides time and cost estimates for positioning new nuclear power systems for commercial deployment. The assessment also estimates the rates at which the new systems might penetrate the domestic market, assuming the continuing viability of the massive light-water reactor network that now exists worldwide. This assessment does not recommend specific, detailed program plans and budgets for individual systems; however, it is clear from this analysis that any of the systems investigated could be deployed if dictated by national interest.

11380 (DOE/NE—0001(Vol.5)) **Nuclear proliferation and civilian nuclear power: report of the Nonproliferation Alternative Systems Assessment Program. Volume V. Economics and systems analysis.** (Department of Energy, Washington, DC (USA)). Dec 1979. 101p. Dep. NTIS, PC A06/MF A01.

This assessment considers the economics of alternative nuclear reactor and fuel-cycle systems in the light of possible patterns of uranium supply and energy demand, as well as the economic implications of improving the proliferation resistance of the various systems. The assessment focuses on the costs of alternative nuclear technologies and the possible timing of their implementation, based on their economic attractiveness. The objectives of this assessment are to identify when economic incentives to deploy advanced nuclear power systems might exist, to estimate the costs of using technologies that would reduce the risk of proliferation, to assess the impact of major economic uncertainties on the transition to new technologies, and to compare the investments required for alternative systems. This information can then be used to assess the potential economic benefits of alternative research, development, and demonstration programs and the timing of those programs.

11381 (DOE/NE—0001(Vol.6)) **Nuclear proliferation and civilian nuclear power: report of the Nonproliferation Alternative Systems Assessment Program. Volume VI. Safety and environmental considerations for licensing.** (Department of Energy, Washington, DC (USA)). Dec 1979. 139p. Dep. NTIS, PC A07/MF A01.

Volume 6 of the Nonproliferation Alternative Systems Assessment Program report addresses safety and environmental considerations in licensing the principal alternative nuclear reactors and fuel cycles in the United States for large-scale commercial nuclear power plants. In addition, this volume examines the safety and environmental considerations for licensing fuel service centers. These centers, which have been proposed for controlling sensitive fuel-cycle facilities and special nuclear materials, would contain a combination of such facilities as reprocessing plants, fabrication plants, and reactors. For this analysis, two fuel service center concepts were selected - one with power-generating capability and one without. This volume also provides estimates of the time required for development of large-scale commercial reactor systems to reach the construction permit application stage and for fuel-cycle facilities to reach the operating license application stage, which is a measure of the relative technical status of alternative nuclear systems.

11382 (DOE/NE—0001(Vol.7)) **Nuclear proliferation and civilian nuclear power: report of the Nonproliferation Alternative Systems Assessment Program. Volume VII. International perspectives.** (Department of Energy, Washington, DC (USA)). Dec 1979. 86p. Dep. NTIS, PC A05/MF A01.

The purpose of this volume is to assess the proliferation vulnerabilities of the present deployment of civilian nuclear-power systems within the current nonproliferation regime and, in light of their prospective deployment, to consider technical and institutional measures and alternatives which may contribute to an improved regime in which nuclear power could play a significant part. An assessment of these measures must include consideration of their nonproliferation effectiveness as well as their bearing upon energy security, and their operational, economic, and political implications. The nature of these considerations can provide some measure of their likely acceptability to various nations. While any final assessment of such measures and alternatives would have to examine the circumstances particular to each nation, it is hoped that the more generic assessments conducted here will be useful in suggesting guidelines for developing an improved nonproliferation regime which also helps to meet nuclear-energy needs. One chapter outlines the existing nonproliferation regime, including the Treaty for the Non-Proliferation of Nuclear Weapons (NPT), International Atomic Energy Agency (IAEA) safeguards, bilateral and multilateral requirements for agreements of cooperation and transfers of technology, and existing provisons for sanctions for violation of nonproliferation commitments. The chapter then proceeds to an assessment of

various alternatives for providing assurance of fuel supply in light of this current regime. Another chapter examines a set of technical and institutional measures and alternatives for various components of once-through and closed fuel cycles. The components of the once-through fuel cycle assessed are enrichment services and spent-fuel management; the components of closed fuel cycles assessed are reprocessing and plutonium management and fast-breeder reactor (FBR) deployment.

11383 (DOE/NE—0001(Vol.8)) **Nuclear proliferation and civilian nuclear power: report of the Nonproliferation Alternative Systems Assessment Program. Volume VIII. Advanced concepts.** (Department of Energy, Washington, DC (USA)). Dec 1979. 112p. Dep. NTIS, PC A06/MF A01.

The six advanced concepts for nuclear power systems that were selected for evaluation are: the fast mixed-spectrum reactor; the denatured molten-salt reactor; the mixed-flow gaseous-core reactor; the linear-accelerator fuel-regenerator reactor; the ternary metal-fueled electronuclear fuel-producer reactor; and the tokamak fusion-fission hybrid reactor. The design assessment was performed by identifying needs in six specific areas: conceptual plant design; reactor-physics considerations; fuel cycle alternatives; mechanical and thermal-hydraulic considerations; selection, development, and availability of materials; and engineering and operability. While none of the six concepts appears to be a credible commercial alternative to the liquid-metal fast-breeder within the Nonproliferation Alternative Systems Assessment Program horizon of 2025, there are a number of reasons for continued interest in the fast mixed-spectrum reactor: it is a once-through cycle fast reactor with proliferation risk characteristics similar to those of the light-water reactor; only about one-third as much uranium is required as for the once-through light-water reactor; the system will benefit directly from fast-breeder development programs; and, finally, the research and development required to develop the high-burnup metal fuel could benefit the on-going liquid-metal fast-breeder reactor program. Accordingly, a limited research and development effort on the high-burnup fuel seems justified, at present.

11384 (DOE/NE—0001(Vol.9)) **Nuclear proliferation and civilian nuclear power: report of the Nonproliferation Alternative Systems Assessment Program. Volume IX. Reactor and fuel cycle descriptions.** (Department of Energy, Washington, DC (USA)). Dec 1979. 612p. Dep. NTIS, PC A99/MF A01.

The Nonproliferation Alternative Systems Assessment Program (NASAP) has characterized and assessed various reactor/fuel-cycle systems. Volume IX provides, in summary form, the technical descriptions of the reactor/fuel-cycle systems studied. This includes the status of the system technology, as well as a discussion of the safety, environmental, and licensing needs from a technical perspective. This information was then used in developing the research, development, and demonstration (RD and D) program, including its cost and time frame, to advance the existing technology to the level needed for commercial use. Wherever possible, the cost data are given as ranges to reflect the uncertainties in the estimates. Volume IX is divided into three sections: Chapter 1, Reactor Systems; Chapter 2, Fuel-Cycle Systems; and the Appendixes. Chapter 1 contains the characterizations of the following 12 reactor types: light-water reactor; heavy-water reactor; water-cooled breeder reactor; high-temperature gas-cooled reactor; gas-cooled fast reactor; liquid-metal fast breeder reactor; spectral-shift-controlled reactor; accelerator-driven reactor; molten-salt reactor; gaseous-core reactor; tokamak fusion-fisson hybrid reactor; and fast mixed-spectrum reactor. Chapter 2 contains similar information developed for fuel-cycle facilities in the following categories: mining and milling; conversion and enrichment; fuel fabrication; spent fuel reprocessing; waste handling and disposal; and transportation of nuclear materials.

11385 (LA—8202-PR) **Evaluation of in-line nondestructive assay systems. Progress report, July 1-September 30, 1979.** Bowersox, D.F.; Ensslin, N.; Hsue, S.T.; Johnson, S.S.; Speir, L.G.; Spirio, C.A.; Tape, J.W.; Walton, G.; Walton, R.B. (Los Alamos Scientific Lab., NM (USA)). Jan 1980. Contract W-7405-ENG-36. 17p. Dep. NTIS, PC A02/MF A01.

Specified instruments for in-line nondestructive assay of process streams in spent nuclear fuels will be tested under realistic conditions for use in effective process control and materials counting. Progress in this project from July 1 to September 30, 1979 is described.

11386 (NUREG/CR—1214(Vol.2)) **Controllable unit approach to material control: application to a high through-put mixed oxide process.** Seabaugh, P.W.; Rogers, D.R.; Woltermann, H.A.; Fushimi, F.C.; Ciramella, A.F. (Mound Lab., Miamisburg, OH (USA)). 10 Jan 1980. Contract EY-76-C-02-0053. 225p. (MLM—2532(Vol.2)). Dep. NTIS, PC A10/MF A01.

This volume contains appendices on: Detailed Description of High-Throughput Mixed-Oxide Fuel Fabrication Process Model; Typical Integrated Material Flows in the High-Throughput Mixed-Oxide Fuel Fabrication Process; Analyses Performed on Analytical Samples Taken in the High-Throughput Mixed-Oxide Fuel Fabrication; Logical Flow Charts for the MRC Mixed-Oxide Process Model; FOCAL and FOCL Command Set Summary; Tabular Maps of Arrayed Variable Files; FOCL/F Program Listings of Process Simulation System ... M02SIM; Process Data File Output; Symbol Definition, Closure Equations, and Summary Tables for Closure Equations Before Refinements; Examles of Computer Print-Out Sheets for Nondiversion and Diversion Conditions in the Mixed-Oxide Process; and Initial Considerations for the Integration of Statistical Information From Closure Equations.

11387 (PB—294343) **Computerized site security monitor and response system. Final rent. on phase 2.** Moore, R.T.; Carpenter, R.J.; Holt, A.W.; Koenig, A.L.; Warnar, R.B.J. (National Bureau of Standards, Washington, DC (USA). Computer Systems Engineering Div.). Mar 1979. 119p. NTIS, PC A06/MF A01.

The Computerized Site Security Monitor and Response System (CSSMRS) was conceived as an integrated, state-of-the-art, computer based system to enhance and improve the overall physical security of storage sites for nuclear weapons and materials. This would result from the interconnection of all site security systems including intrusion detection equipment, duress alarms, guard radio and telephone systems, guard activity sensors, access control equipments, meteorological and environmental sensors and deterrent systems to a distributed processing network of computers. These would be expected to provide timely, accurate and unambiguous information about the site security status or the progress of an attack or intrusion attempt. To the extent that is feasible, appropriate response initiatives would be preprogrammed into the system. Changes in site security status and the resulting response actions would be automatically reported upchannel to higher command levels and backup and reserve forces would be automatically called out in the event of certain identifiable threat situations, particularly those in which continued survival of local guard forces might be doubtful.

11388 (SAND—78-0689) **Wiring for the secure storage module for the Plutonium Protection System.** Arlowe, H.D. (Sandia Labs., Albuquerque, NM (USA)). Dec 1979. Contract EY-76-C-04-0789. 52p. Dep. NTIS, PC A04/MF A01.

The wiring for the SSM is divided into two major subsystems: the logic subsystem and the power subsystem. The logic subsystem uses flat ribbon cables and printed wiring cards for low-level signal distribution. Its primary purpose is to provide communications from the Container Modules (CMs) directly to the microcomputer in the SSM Controller. The power subsystem uses conventional cables and does not generally handle signals of less than 30 volts. The 110V ac power is routed to all equipment in the Electronic Enclosure and to cubicle cooling fans. Wiring for drive power and monitor signals for the carrousel stepper motors, deadbolts, and CM-locking solenoids are provided, as well as for the annuciator status lights and tamper switches.

11389 (SAND—79-0224) **Automated electronic intruder simulator for evaluation of ultrasonic intrusion detectors.** (Sandia Labs., Albuquerque, NM (USA)). Jan 1979. Contract EY-76-C-04-0789. 42p. Dep. NTIS, PC A03/MF A01.

An automated electronic intruder simulator for testing ultrasonic intrusion detectors is described. This simulator is primarily intended for use in environmental chambers to determine the effects of temperature and humidity on the operation of ultrasonic intrusion detectors.

ADMINISTRATIVE AND REGULATORY

REFER ALSO TO CITATION(S) 12007

FUSION FUELS

PROCESSING

FABRICATION AND TESTING

11390 (SAND—79-1941C) **Calibration model for the DCXC x-ray camera.** Fehl, D.L.; Chang, J. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 4p. (CONF-800208—6). Dep. NTIS, PC A02/MF A01.

From Tropical meeting on inertial confinement fusion; San Diego, CA, USA (26 Feb 1980).

A physical model for the DCXC camera used in x-radiographic studies of inertial confinement fusion (ICF) targets is described. Empirical calibration procedures, based on pulsed, bremsstrahlung sources, are proposed.

11391 (SAND—79-1942C) **Target fabrication for particle beam fusion.** Bieg, K.W.; Chang, J. (Sandia Labs., Albuquerque, NM

(USA)). 1980. Contract EY-76-C-04-0789. 4p. (CONF-800208—5). Dep. NTIS, PC A02/MF A01.

From Tropical meeting on inertial confinement fusion; San Diego, CA, USA (26 Feb 1980).

Near-term exploding pusher targets for electron or light ion beam driven fusion are typically several mm in diameter and have relatively thick shells (rho r ~ 0.001 to 0.03 gm/cm^2). Current fabrication techniques utilize parylene polymer coatings on leachable mandrels.

11392 (UCRL—80269(Rev.1)) **Technique for full surface examination of small spheres in the scanning electron microscope.** Ward, C.M.; Hendricks, C.D.; Weinstein, B.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Apr 1978. Contract W-7405-ENG-48. 17p. (CONF-780415—6(Rev.1)). Dep. NTIS, PC A02/MF A01.

From Scanning electron microscopy conference; Los Angeles, CA, USA (16 Apr 1978).

In response to the increasing severity of target surface finish requirements for laser fusion experiments, it has become necessary to examine spherical targets in the Scanning Electron Microscope, prior to laser irradiation, on an orderly nondestructive basis. We have developed a new sample manipulation technique which rolls a thin wall sphere through 4π steradians, minimizes damage and allows easy recovery. The sphere is placed between two parallel plane surfaces formed in conductively coated silicone rubber on the ends of capillaries. Mechanical slides cause the capillaries to translate laterally and roll the ball bringing the entire surface of the sphere into a position for examination. Resolutions comparable with traditional mounting techniques are attained. A side looking, Si(Li) detector increases the utility of the system by allowing simultaneous energy dispersive x-ray microanalysis. The entire detector assembly slips between the secondary electron detector and the sphere rolling capillaries to collect x-rays from the target.

11393 (UCRL—82752) **Electrostatic levitation, control and transport in high rate, low cost production of inertial confinement fusion targets.** Hendricks, C.D.; Johnson, W.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 May 1979. Contract W-7405-ENG-48. 14p. (CONF-7910107—1). Dep. NTIS, PC A02/MF A01.

From IEEE-IAS conference on "electrostatics"; Cleveland, OH, USA (1 Oct 1979).

Inertial confinement fusion requires production of power plant grade targets at high rates and process yield. A review of present project specifications and techniques to produce targets is discussed with special emphasis on automating the processes and combining them with an electrostatic transport and suspension system through the power plant target factory.

11394 (UCRL—83234) **Automatic x-ray image analysis and sorting of laser fusion targets.** Singleton, R.M.; Perkins, D.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Aug 1979. Contract W-7405-ENG-48. 5p. (CONF-800208—1). Dep. NTIS, PC A02/MF A01.

From Tropical meeting on inertial confinement fusion; San Diego, CA, USA (26 Feb 1980).

A microcomputer-based x-ray image analysis system to select and measure laser fusion targets is described. This system positions a photographic plate in x and y, focuses a microscope image, digitizes and extracts measurements within seconds.

BY-PRODUCTS

REFER ALSO TO CITATION(S) 11282

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

RADIATION SOURCES

OTHER INDUSTRIAL USES

REFER ALSO TO CITATION(S) 12151

11395 **Department of Energy's beneficial uses of radioisotopes program.** Henoch, W.W.; Remini, W.C.; Burnett, J.L. (Department of Energy, Washington, D.C. (USA)). *Proc. Jpn. Conf. Radioisot.;* No. 13, 265-278(May 1978).

From 13. Japan conference on radioisotopes; Tokyo, Japan (7 - 9 Dec 1977).

The US D.O.E. is conducting the comprehensive program to develop the necessary technologies for the cost/beneficial uses of existing and future surplus radioactive materials that result primarily from nuclear fuel reprocessing. For the past several years, the U.S. DOE has been sponsoring a program to develop the technology and investigate the potential of using gamma irradiation to reduce pathogen levels in sewage sludge, in cooperation with the Environmental Protection Agency. ^{137}CS irradiation is being studied for the treatment of waste to be used both for land application and for animal feeding. ^{85}Kr potentially has wide applications. Enrichment of ^{85}Kr is presently possible through one of three methods, of which the thermal diffusion process is only suitable for the production of large amounts of Krypton. One promising use of ^{85}Kr is self-luminous lights needing no external power source. Pacific Northwest Laboratories is currently investigating the possibility of using ^{90}Sr for unattended power generators using the heat of the beta emission. This technology has already been demonstrated, and the U.S. Navy is now using ^{90}Sr to provide power to certain weather stations. Since the later 1960's ^{241}Am has been sold to industry for a wide variety of applications. Plutonium-238 (even at 40 % enrichment) is superior to ^{241}Am as neutron sources because of its higher specific activity, but ^{238}Pu carries restrictions on licensing, transport, and export. In future, circumstances would force shift from Am to Pu as neutron sources.

ISOTOPIC POWER SUPPLIES

11396 (AD-A—066059) **SAP IV analysis of a reentering multi-hundred watt heat source assembly. Final report.** Crawford, M.L. (Air Force Weapons Lab., Kirtland AFB, NM (USA)). Sep 1978. 29p. NTIS, PC A03/MF A01.

The results of a three-dimensional stress analysis of a reentering Multi-Hundred Watt Heat Source Assembly are presented. The SAP IV computer program was used for a static analysis of the aeroshell for the maximum stress reentry hypothesized for the NASA Voyager launches. The temperature profile through the aeroshell thickness was applied with given external aerodynamic and inertial loads, and because the axial thermal gradients are unknown at the point of maximum combined stress, a longitudinal temperature gradient which is present at 0.4 seconds later in the reentry is used. Therefore, the results can only be used for order-of-magnitude estimates of the increase in calculated stress, and they indicate an increase on the order of 10 percent over previous SAP IV calculations.

11397 (N—79-20219) **The kw power module evolution study: executive summary.** (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA (USA)). 27 Feb 1979. Contract NAS8-32928. 48p. NTIS, PC A03/MF A01.

Using the Marshall Space Flight Center 25 kW Power Module (PM) reference design as a point of departure, the study defined evolutionary growth paths to 100 kW and above. A recommended development approach and initial configurations were described. Specific hardware changes from the reference design are recommended for the initial PM configuration to ensure evolutionary growth, improved replicability, and reduced cost. Certain functional changes are also recommended to enhance system capabilities.

DESIGN AND FABRICATION

11398 (LA—8184-PR) **General-Purpose Heat Source Project, Space Nuclear Safety Program, and Radioisotopic Terrestrial Safety Program. Progress report, October 1979.** Maraman, W.J. (comp.). (Los Alamos Scientific Lab., NM (USA)). Dec 1979. Contract W-7405-ENG-36. 37p. Dep. NTIS, PC A03/MF A01.

The formal monthly report covers the studies related to the use of $^{238}PuO_2$ in radioisotopic power systems carried out for the Advanced Nuclear Systems and Projects Division of the Los Alamos Scientific Laboratory. The three programs involved are: General-Purpose Heat Source Development; Space Nuclear Safety; and Radioisotopic Terrestrial Safety.

11399 (PNL—1845-44) **Quarterly report on the strontium heat source development program, Advanced Nuclear Systems and Projects Division for July-September 1979.** Fullam, H.T. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Oct 1979. Contract EY-76-C-06-1830. 17p. Dep. NTIS, PC A02/MF A01.

Metallographic examination of the metal specimens exposed to $^{90}SrF_2$ for 20,000 h was completed, as was the examination of the specimens exposed to nonradioactive SrF_2 for 30,000 hours. Fabrication and welding of the prototype capsules to be used in the qualification testing program was completed.

HYDROGEN

PRODUCTION

REFER ALSO TO CITATION(S) 11081, 11583

11400 (AD-A—068452) **Hydrogen generator subsystem, catalyst and equipment development for thermo-catalytic cracker. Final technical report.** Henry, R. (IIT Research Inst., Chicago, IL (USA)). Nov 1978. Contract DAAG53-76-C-0081. 187p. NTIS, PC A09/MF A01.

Future Army plans call for generation of silent electrical power in field situations. Hydrogen/air fuel cells are considered viable electrical power generators. Currently available logistic fuels are hydrocarbon; requiring a fuel conditioning process to free hydrogen for use by the fuel cell. This report concerns one such process to obtain hydrogen from hydrocarbon fuels. Experimental work is aimed at optimizing a catalyst for catalytic cracking and the development of a breadboard hydrogen generator. Further work is needed in both these areas.

11401 (UCRL—83771) **Materials problems in production, transport, and storage of hydrogen.** Krikorian, O.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Jan 1980. Contract W-7405-ENG-48. 13p. Dep. NTIS, PC A02/MF A01.

Advanced technologies for hydrogen production include thermochemical cycles, advanced water electrolysis, and high temperature steam electrolysis. In hydrogen production by thermochemical cycles, materials problems center primarily around an H_2SO_4 boiler, and H_2SO_4 vapor decomposer, and an HI decomposer. Adequate materials are available for these applications, but further development is desirable to reduce fabrication and design problems and extend equipment lifetimes. In advanced electrolytic hydrogen production, the main thrust has been to raise cell efficiencies by raising operating temperatures and pressures using two approaches: (1) an alkaline electrolyte cell, and (2) a solid polymer electrolyte cell. The more extreme conditions in these advanced cells lead to the need for more corrosion resistant separator and electrode materials. Also, in order to maximize operating efficiency, new low-cost electrocatalysts are needed to reduce electrode overpotentials. It is especially desirable to reduce or even eliminate the use of noble metals as electrocatalysts to reduce costs. In high temperature steam electrolysis, materials problems include development of solid state electrolytes for oxide ion conduction, and electrically conductive anode, cathode and interconnecting materials for cells. Hydrogen transport is expected to be primarily by pipeline, and materials problems here deal with pipeline steels for transport of gaseous hydrogen. Long term storage of hydrogen on a large scale is anticipated to be in underground repositories much as natural gas is stored today. However for short-term or small scale uses, hydrogen storage in hydrides, or storage in glass microballoons offer certain operational advantages, such as utility in vehicular transportation and safety. Some of the materials studies on hydride and microballoon storage are briefly mentioned.

ELECTROLYSIS

REFER ALSO TO CITATION(S) 11077, 12247

11402 **Mechanism of the formation of dihydrogen from the photoinduced reactions of tris(bipyridine)ruthenium(II) with tris(bipyridine)rhodium(III).** Brown, G.M.; Chan, S.F.; Creutz, C.; Schwarz, H.A.; Sutin, N. (Brookhaven National Lab., Upton, NY). *J. Am. Chem. Soc.;* **101**: No. 25, 7638-7640(5 Dec 1979).

Visible light irradiation of aqueous solutions of $Ru(bpy)_3^{2+}$, $Rh(bpy)_3^{3+}$, triethanolamine TEOA/TE OAH^+ (pH 8.1), and K_2PtCl_4 (or K_2PtCl_6) yields dihydrogen with a quantum yield of up to 0.11 +- 0.01 mol einstein^{-1} depending on the conditions used. The dihydrogen is the end product of a sequence of electron-transfer reactions. $Ru(bpy)_3^{2+}$ formed by visible light absorption is oxidized by $Rh(bpy)_3^{3+}$ to produce $Rh(bpy)_3^{2+}$ and $Ru(bpy)_3^{3+}$. The latter is rapidly reduced by TEOA. In the absence of platinum, the rhodium(II) disproportionates to give rhodium(III) and rhodium(I); in the presence of platinum, the rhodium(II) may either disproportionate or yield dihydrogen. Observations on the photochemical and dark reactions in this system are reported. The rhodium system is more expensive than that based on methylviologen and is subject to efficiency-lowering side reactions. 1 figure. (DP)

THERMOCHEMICAL PROCESSES

REFER ALSO TO CITATION(S) 11077, 11673, 11683

11403 (CEA-CONF—4363) **Thermal decomposition of hydroiodic acid and hydrogen separation.** Yeheskel, J.; Leger, D.; Courvoisier, P. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Recherche et Analyse). 1978. 26p. (CONF-780807—15). Dep. NTIS (US Sales Only), PC A03/MF A01.

From 2. world hydrogen energy conference; Zurich, Switzerland (21 Aug 1978).

The reaction of decomposition of hydriodic acid is included in a promising water splitting process (sulfur-iodine cycle). An experimental program is running in order to overcome some basic difficulties and data shortcomings which stand in the way of achieving that target. The core of the experimental system is the palladium silver (23% Ag) membrane tube reactor in which the feed gas entered the inner side of the tube. Four series of different kinds of experiments have been performed: 1) diffusion of hydrogen from a pure feed hydrogen stream through the membrane; the results are statistically analyzed due to the present correlations of the H_2 specific permeability as a function of temperature and pressure (up to 600°C and 20 bar); 2) separation of hydrogen from a binary feed mixture H_2-He; a mathematical model is developed for this operation; 3) indication of the poisoning effect of a little amount of hydriodic acid on the hydrogen pereability; this effect is partly reversible at high temperatures; 4) a performance of one continuous experiment of HI decomposition into the membrane tube at steady pressure and temperature of 8 bar and 500°C; the results prove the catalytic activity of the membrane surface.

11404 (CEA-CONF—4364) **Energy balance calculations and assessment of two thermochemical sulfur cycles.** Leger, D.; Lessart, P.; Manaud, J.P.; Benizri, R.; Courvoisier, P. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Recherche et Analyse). 1978. 14p. (CONF-780807—13). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 2. world hydrogen energy conference; Zurich, Switzerland (21 Aug 1978).

Thermochemical cyclic processes which include the highly endothermal decomposition of sulphuric acid are promising for hydrogen production by water-splitting. Our study is directed toward two cycles of this family, each involving the formation and decomposition of sulphuric acid and including other reactions using iron sulphide for the first and oxides and bromides of copper and magnesium for the second. Thermochemical analyses of the two cycles are undertaken. Thermodynamic studies of the reactions are carried out, taking into account possible side-reactions. The concentration of reactants, products and by-products resulting from simultaneous equilibria are calculated, the problems of separation thoroughly studied and the flow-diagrams of the processes drawn up. Using as heat source the helium leaving a 3000 MWth high temperature nuclear reactor and organizing internal heat exchange the enthalpy diagrams are drawn up and the net energy balances evaluated. The overall thermal efficiencies are about 28%, a value corresponding to non-optimized process schemes. Possible improvements aiming at energy-saving and increased efficiency are indicated.

11405 (CEA-CONF—4365) **Hydrogen-producing cycles using the decomposition of hydrogen bromide.** Lessart, P.; Benizri, R.; Courvoisier, P. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Recherche et Analyse). 1978. 22p. (CONF-780807—14). Dep. NTIS (US Sales Only), PC A03/MF A01.

From 2. world hydrogen energy conference; Zurich, Switzerland (21 Aug 1978).

The sulphur-bromide cycle is a promising three-reaction sequence using the decomposition of hydrogen bromide to produce hydrogen. Electrolysis is a possible way to decompose HBr and research is in progress at Ispra to decrease the overvoltage. Thermolysis of HBr is studied as an alternative in this paper. Two-step thermal splitting processes are investigated and can be written: $2\,X + 2\,HBr \rightarrow 2\,X\,Br + H_2$; $2\,X\,Br \rightarrow 2\,X + Br_2$ where X may be a metal bromide, oxybromide or oxide. Nine metals are considered: Cr, Cu, Fe, Mo, Pb, Sn, Ti, V, W. Firstly a literature survey is made to establish a complete set of thermochemical data for the metal compounds. When the heat capacity and entropy are unknown, classical correlation rules are used to estimate these thermochemical values. Secondly the free energy of reactions which decompose HBr are calculated as a function of temperature and pressure. Some side reactions are also taken into account to evaluate concentrations of products. Finally three interesting two-reaction sequences (with Cr, V and W) are selected. In each the endothermal step is the bromine evolution. The temperature, heat requirement and corresponding pressure are given and a rough estimation of the water splitting efficiency are indicated for each process.

STORAGE

REFER ALSO TO CITATION(S) 11401

11406 (UCRL—52865) **Hydrogen encapsulation in a Cs-exchanged type 4A zeolite.** Turi, P.L.; Lakner, J.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Sep 1979. Contract W-7405-ENG-48. 12p. Dep. NTIS, PC A02/MF A01.

H_2 encapsulation in a Cs-exchanged synthetic type 4A zeolite was observed. Hydrogen storage capacity v [in cm^3 H_2(STP) per gram zeolite] was measured in samples in which $Na^+ \rightarrow Cs^+$ exchange was from 19 to 61%. The samples were loaded with H_2 at temperatures from 350 to 420°C, at pressures up to 20,000 psi. In a sample with 43% exchange, loaded at 420°C, H_2 storage capacity varied with loading pressure (in psi) as $v = 0.018p^{0.82}$. In sapmles loaded at 10,000 psi, 350°C, storage capacity appeared to have a maximum at about 46% exchange (unit cell contents $Cs_{6.8}Na_{6.8}$).

CHEMISORPTION

11407 (SAND—79-8646) **Technologies and economics of small-scale hydrogen storage.** Robinson, S.L.; Iannucci, J.J. (Sandia Labs., Livermore, CA (USA)). Dec 1979. Contract EY-76-C-04-0789. 51p. Dep. NTIS, PC A04/MF A01.

Presently available and future fixed-site hydrogen storage technologies are examined, to identify the minimum cost storage technique for various combinations of quantity, cycling frequency and parasitic energy costs. The forms studied are, pressurized gas, cryogenic liquid, hydride, and microballoon storage. For each form, installed capital cost, filling and emptying equipment costs and parasitic energy costs are developed and parameterized by electric rates. The energy intensive systems are economical for long-term cycling (seasonal storage) but unfavorable for short term (daily cycling). Low-pressure gas storage is favored for short term and intermediate term storage. Development of microballoon storage is recommended as a possible low-cost long-term storage option.

CRYOGENIC

REFER ALSO TO CITATION(S) 11407

TRANSPORT

REFER ALSO TO CITATION(S) 11401

11408 (COO—2907-30) **Study of the behavior of gas distribution equipment in hydrogen service. Final report, April 1, 1976-December 31, 1978.** Johnson, D.G.; Jasionowski, W.J. (Institute of Gas Technology, Chicago, IL (USA)). Apr 1979. Contract EY-76-C-02-2907. 233p. Dep. NTIS, PC A11/MF A01.

The results of this 2-3/4 year program show that no special maintenance or safety constraints are necessary when dry, pure hydrogen is carried in modern, well-maintained piping systems composed of conventional natural gas distribution components. Volumetric flow metering requirements were identified as the only significant operational problem. When the normal condition of turbulent or partially turbulent flow exists, our model distribution loops showed energy delivery for hydrogen to be at least 80% that of natural gas under the same operating conditions. Several general and important conclusions are stated below. Natural gas (or methane) leak rates are roughly equivalent to hydrogen leak rates on an energy basis (e.g. Btu/hour). Hydrogen exposure at the moderate temperatures and pressures encountered in the experimental gas distribution models did not create materials problems or related safety problems. However, there was a measurable change in the physical properties of plastic pipe, some adhesives, and some lubricants. Due to the three-fold increase in volumetric flow rate of hydrogen required for equivalent natural gas energy delivery rates, existing meters may be undersized due to mechanical limitations and affect metering accuracy and lifetime. Test data are inconclusive, but gas flow metering accuracy, even within rated meter capacity, may be less with hydrogen than with natural gas when employing conventional metering equipment. Meters may have to be replaced for hydrogen service. Throttling of hydrogen at conventional pressure regulating stations or as a result of major leaks does not create conditions conducive to large temperature rises due to Joule-Thomson heating. Thus the potential safety hazard of autoignition of hydrogen, due to throttling does not exist under gas distribution operating conditions.

OTHER SYNTHETIC AND NATURAL FUELS

HYDROCARBON FUELS

REFER ALSO TO CITATION(S) 11259

11409 (DOE/ERA—0021) **Environment assessment: allocation of petroleum feedstock, Algonquin SNG Inc., Freetown SNG Plant, Bristol County, MA.** (Department of Energy, Washington, DC (USA). Economic Regulatory Administration). Jan 1980. 164p. Dep. NTIS, PC A08/MF A01.

The proposed administrative action to deny, grant or modify the Algonquin SNG, Inc. (Algonquin) petition for an adjusted allocation of naphtha feedstock may significantly affect the ehuman environment. The volume of feedstock requested is 4,425,571 barrels per year of naphtha to be used in Algonquin's Freetown, MA synthetic natural gas (SNG) plant. Environmental impacts of 100, 78, and 49% allocations were evaluated.

PROPERTIES

REFER ALSO TO CITATION(S) 11272

11410 (SAND—79-8717) **Laser absorption measurements of OH in a methane-air flat flame.** Cattolica, R.J. (Sandia Labs., Livermore, CA (USA)). Dec 1979. Contract EY-76-C-04-0789. 79p. (CONF-791048—5). Dep. NTIS, PC A05/MF A01.

From The Combustion Institute Western States Section meeting; Berkeley, CA, USA (15 Oct 1979).

The OH radical concentration and rotational temperature were measured in atmospheric pressure methane-air flat flames using absorption spectra obtained with a tunable dye laser. The OH radical nonequilibrium and the associated recombination in the post flame gases were observed for fuel-air equivalence ratios of .8, .9, 1.0, 1.1, 1.2. The predicted peak OH concentrations from one-dimensional laminar flame models were found to be in good agreement with the measured values. The OH decay profiles were consistent with a second-order dependence of the decay on the OH concentration. Although this dependence is associated with the recombination chemistry for the fuel-rich flames, it appears that for the lean flames diffusional transport is responsible. The OH decay rate constant was nearly the same for the stoichiometric and lean conditions, but was found to increase substantially for the fuel-rich conditions. 25 figures, 5 tables.

PREPARATION

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 11081, 11421, 11577, 11578, 11580

11411 (COO—2917-13) **Biological conversion of biomass to methane corn stover studies. Project report, December 1, 1977-August 1, 1978.** Pfeffer, J.T.; Quindry, G.E. (Illinois Univ., Urbana (USA). Dept. of Civil Engineering). Jun 1979. Contract EY-76-S-02-2917. 171p. Dep. NTIS, PC A08/MF A01.

A series of experiments was conducted to determine the performance characteristics of the methane fermentation process using corn stover obtained from the University of Illinois farms and processed through four parallel fermenters each having a capacity of 775 liters. A continuous feed system was employed to determine the conversion efficiency. The dewatering characteristics of the effluents and the quality of the liquid and solid residues were determined. The biodegradability of corn stover is low. Data obtained at a fermentation temperature of 59 +-1°C show that only 36 percent of the volatile solids are biodegradable. The first order rate constant for this conversion was found to be 0.25 day^{-1}. Pretreatment with caustic (NaOH) concentration of 0.30 molar (5 g/100 g dry stover) and a temperature of 115°C for one hour increased the biodegradable fraction to 71 percent of the volatile solids. The reactor slurries were easily dewatered by both vacuum filtration and centrifugation. Corn stover does not appear to be attractive economically at the present energy prices. At a chemical cost of $154/tonne ($140/ton), the NaOH pretreatment adds approximately $5.2/tonne to the cost of processing the stover. At a methane yield of 0.25 m^3/kg of solids fed, this adds a total cost of $2/100 m^3 ($0.57/MCF) for this process alone. Addition of stover acquisition costs ($20/dry tonne of stover), total processing costs without gas cleanup ($21/tonne) and residue disposal ($3/tonne of wet cake), the cost of fuel gas would be in the neighborhood of $9.76/GJ ($10.30/10^6 Btu).This cost excludes all profit, taxes, etc. associated with private financing. Depending upon financing methods, tax incentives, etc., it may be necessary to add up to an additional $2.00/GJ to the cost of this fuel gas.

11412 (COO—2981-11) **Anaerobic fermentation of agricultural residues: potential for improvement and implementation. Eleventh quarter progress report, December 16, 1978-March 15, 1979.** Jewell, W.J. (Cornell Univ., Ithaca, NY (USA). Dept. of Agricultural Engineering). 1979. Contract EY-76-S-02-2981. 33p. Dep. NTIS, PC A03/MF A01.

The Cornell University project on production of methane from agricultural residues has as its main goal the development of a low-cost methane gas generation system for use on small agricultural operations. Five different types of anaerobic fermentor reactor designs are presently being operated, with the majority of effort focused on two full scale reactors (both about 35m³) designed to process the residues produced by 65-cow dairies. Three pilot units (5m³ volume) are being operated to determine the limits of operation variables -- temperature, labor inputs, mixing, and bedding composition. Variables being evaluated with the pilot reactors include: temperature of operation (25°C and 35°C), straw and sawdust bedding addition, intermittent feeding (once per day to once per week), mixing (none to once per 4 days), and moisture content (90 percent to 60 percent moisture). The low-cost full scale plug flow reactor has now been operated for nearly one year, including the winter with the lowest temperature (down to minus 25°C) for the longest period recorded for the northern New York area. Preliminary analysis of the data indicates more efficient solids conversion with the plug flow design (41 percent TVS destruction efficiency) than with the completely mixed full scale system (31.7 percent TVS destruction efficiency) when operating at a 30-day hydraulic retention time at 35°C. Although analysis of the thermal data is incomplete, comprehensive heat loss studies were conducted during the cold period.The efficiency of the boiler-hot water heating system varied bewteen 40 and 55 percent. The net energy production during the coldest conditions (worst case) was estimated to be 44 percent at a 15-day HRT at 35°C with the low-cost plug flow system. Considerable operatonal problems with the full scale systems occurred during the coldest winter period; but these problems were not caused by the weather.

11413 (COO—2981-12) **Anaerobic fermentation of agricultural residues: potential for improvement and implementation. Twelfth quarter progress report, 16 March 1979-15 June 1979 and Addendum describing project activities, 16 June 1979-15 October 1979.** Jewell, W.J. (Cornell Univ., Ithaca, NY (USA). Coll. of Agriculture and Life Sciences). 1979. Contract EY-76-S-02-2981. 53p. Dep. NTIS, PC A04/MF A01.

Five different types of anaerobic fermentor reactor designs were operated, with the majority of effort focused on two full scale reactors (both about 35m³), each designed to process the manure residues from up to 65 dairy cows. Three pilot units (5m³ volume) are being operated to determine the limits of operation variables - temperature, labor inputs, mixing, and bedding composition. The low-cost full scale plug flow reactor has now been operated for more than one year, including the winter with the lowest temperature for the longest period recorded for the northern New York area. During the twelfth quarter the full scale plug flow and conventional control reactors were tested in parallel at new conditions of 15 days and 10 days HRT, 35°C and 10 to 12% TS manure feed. Steady state results for the 15 day HRT condition once more indicated a more efficient solids conversion with the plug flow design (34.1% TVS destruction efficiency) than with the completely mixed full scale system (27.8% TVS destruction efficiency) when operated on dairy manure (13% TS) at 35°C. No serious operational problems have been encountered with either full scale reactor during the twelfth quarter. Thermal data from the plug flow reactor has now been obtained for a full year cycle. The apparent overall efficiency of the boiler and reactor heating systems varied between 40 and 55%. In order to translate the temperature and operating data of the plug flow unit into a comprehensible energy balance, a computer model for the prediction of energy production and for the description of conducted heat losses and feed heating requirements was developed. Data analysis and the development of certain sections of the final report were given considerable attention throughout the twelfth quarter. The preparation of the farmer's feasibility manual was also initiated during this period.

11414 (COO—2991-42) **Analysis of digester design concepts.** Ashare, E.; Wilson, E.H. (Dynatech R/D Co., Cambridge, MA (USA)). 29 Jan 1979. Contract EY-76-C-02-2991. 320p. Dep. NTIS, PC A14/MF A01.

Engineering economic analyses were performed on various digester design concepts to determine the relative performance for various biomass feedstocks. A comprehensive literature survey describing the state-of-the-art of the various digestion designs is included. The digester designs included in the analyses are CSTR, plug flow, batch, CSTR in series, multi-stage digestion and biomethanation. Other process options investigated included pretreatment processes such as shredding, degritting, and chemical pretreatment, and post-digestion processes, such as dewatering and gas purification. The biomass sources considered include feedlot manure, rice straw, and bagasse. The results of the analysis indicate that the most economical (on a unit gas cost basis) digester design concept is the plug flow reactor. This conclusion results from this system providing a high gas production rate combined with a low capital hole-in-the-ground digester design concept. The costs determined in this analysis do not include any credits or penalties for feedstock or by-products, but present the costs only for conversion of biomass to methane. The batch land-fill type digester design was shown to have a unit gas cost comparable to that for a conventional stirred tank digester, with the potential of reducing the cost if a land-fill site were available for a lower cost per unit volume. The use of chemical pretreatment resulted in a higher unit gas cost, primarily due to the cost of pretreatment chemical. A sensitivity analysis indicated that the use of chemical pretreatment could improve the economics provided a process could be developed which utilized either less pretreatment chemical or a less costly chemical. The use of other process options resulted in higher unit gas costs. These options should only be used when necessary for proper process performance, or to result in production of a valuable by-product.

11415 (DSE—2404-T2) **Engineering feasibility of fuels from biomass utilizing dairy farm residue.** Skrinde, R.T. (Tracey and Brunstrom Co., Seattle, WA (USA)). 1 Jul 1978. Contract EX-76-C-01-2404. 37p. Dep. NTIS, PC A03/MF A01.

The design and operation of a fermentation facility at the Monroe State Dairy Farm. Washington, which produces methane gas from cattle manure was described. The Monroe process was evaluated and the feasibility of adapting the process to energy production on US farms was discussed. Pipe sizes, types of pumps used, and other factors which bear on operation were evaluated and design changes were recommended. Equipment costs and long term operating costs were also evaluated. (DC)

11416 (LBL—10092) **LBL Continuous Biomass Liquefaction Process Engineering Unit (PEU).** Figueroa, C.; Wrathall, J.; Ergun, S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 7p. (CONF-791166—2). Dep. NTIS, PC A02/MF A01.

From Thermochemical conversion contractors' meeting; Rolla, MO, USA (7 Nov 1979).

11417 (LBL—10093) **Pretreatment of biomass prior to liquefaction.** Schaleger, L.L.; Yaghoubzadeh, N.; Ergun, S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 7 Nov 1979. Contract W-7405-ENG-48. 9p. Dep. NTIS, PC A02/MF A01.

The hydrolytic pretreatment of wood flour (prepared at Albany from Douglas Fir chips) using 500 ppM sulfuric acid is sometimes ineffective because neutralization of acid occurs during the reaction. This phenomenon has been investigated and is tentatively ascribed to the presence of base-forming impurities. The problem can be overcome by using higher concentrations of acid, e.g., 1000 ppM. The final concentration of insoluble solids in a pretreated wood slurry prepared from a 1-to-4 mixture of wood-to-water is about 15%. The solids in these pretreated slurries settle at rates on the order of 10^{-2} ft/sec. These slurries are therefore still unsuitable for pumping in a slow, laminar flow system such as the one at Albany. However, two options for retarding settling appear promising. In the first, the pretreated slurry is homogenized by blending with air using a high speed mixer. In the second, a pretreated slurry prepared from chips is passed through a conventional disc refiner. This report focusses on the problem of pH control.

11418 (PB—293165) **Recovery, processing, and utilization of gas from sanitary landfills. Final report mar 77-sep 78.** Ham, R.K.; Hekimian, K.K.; Katten, S.L.; Lockman, W.J.; Lofy, R.J. (Lockman and Associates, Monterey Park, CA (USA)). Feb 1979. Contract EPA-68-03-2536. 147p. NTIS PC A07/MF A01.

The report is organized into seven sections. Following the introduction and conclusions and recommendations, are sections describing: the three-component gas generation phenomenon; analysis and comparison of alternative gas utilizations including the processes necessary to prepare the gas for use; an evaluation of various landfill design approaches and operations techniques that show promise for enhancing gas generation, recovery efficiency and quality; recommendations for research, development and demonstration projects deemed necessary to develop an adequate data base to proceed with more in depth engineering evaluations of the various options. Overall, it is shown that landfill gas recovery, processing and utilization is technically feasible and can be economically viable.

11419 (SERI/TP—33-285, pp 303-308) **Methane from agriculture residues process conversion efficiencies.** Pfeffer, J.T. (Univ. of Illinois, Urbana). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

A large scale laboratory anaerobic fermentation system has been constructed to evaluate the efficiency of converting various agriculture residues to fuel gas. The system consists of four completely mixed and heated reactors with a working volume of 775 liters (205 gal). The system operates in a semicontinuous mode, receiving feed slurry every hour. Various feed stocks, including beef feed lot manure, corn stover and wheat straw have been tested at various retention times, fermentation temperatures and pretreatment techniques. Only the results of the corn stover and wheat straw studies are presented in this paper. The results show that the biode-

gradability of the substrates can vary substantially. The volatile solids in corn stover were found to be only 36% biodegradable at a fermentation temperature of 58 to 60°C. However, a mild thermochemical pretreatment increased the biodegradable volatile solids to 77%. Wheat straw that had been steam treated at 115°C to enhance water absorption was found to have volatile solids that were 49% biodegradable.

11420 (SERI/TR—312-471) **Report on the design and operation of a full-scale anaerobic dairy manure digester. Final report.** Coppinger, E.; Brautigam, J.; Lenart, J.; Baylen, D. (Ecotope Group, Seattle, WA (USA)). Dec 1979. Contract EG-77-C-01-4042. 87p. Dep. NTIS, PC A05/MF A01.

A full-scale anaerobic digester on the Monroe State Dairy Farm was operated and monitored for 24 months with funding provided by the United States Department of Energy, Fuels from Biomass Systems Branch. During the period of operation, operating parameters were varied and the impact of those changes is described. Operational experiences and system component performance are discussed. Internal digester mixing equipment was found to be unnecessary, and data supporting this conclusion are given. An influent/effluent heat exchanger was installed and tested, and results of the tests are included. Recommendations for digester design and operation are presented. Biological stability was monitored, and test results are given. Gas production rates and system net energy are analyzed. The economics of anaerobic digestion are evaluated based on various financing options, design scales, and expected benefits. Under many circumstances digesters are feasible today, and a means of analysis is given.

ALCOHOL FUELS

REFER ALSO TO CITATION(S) 12170, 12171

PROPERTIES

REFER ALSO TO CITATION(S) 11193

PREPARATION

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 11586

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 11576, 11577, 11580, 12584, 12591

11421 (N—79-19450) **Bioconversion study conducted by JPL.** Kalvinskas, J. (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Nov 1978. Contract NAS7-100. 124p. NTIS PC A06/MF A01.

The Jet Propulsion Laboratory (JPL) of Caltech conducted a study of bioconversion as a means of identifying the role of biomass for meeting the national energy fuel and chemical requirements and the role and means for JPL-Caltech involvement in bioconversion. The bioconversion study included the following categories; biomass sources, chemicals from biomass, thermochemical conversion of biomass to fuels, biological conversion of biomass to fuels and chemicals, and basic bioconversion sciences. A detailed review is included of the bioconversion fields cited with specific conclusions and recommendations given for future research and development and overall biomass system engineering and economic studies.

PROPERTIES

11422 (AD-A—065829) **Ozone oxidation of hydrazine fuels. Final report June-September 1978.** Sierka, R.A.; Cowen, W.F. (Civil and Environmental Engineering Development Office, Tyndall AFB, FL (USA). Detachment 1 (ADTC)). Sep 1978. 117p. NTIS, PC A06/MF A01.

This research centered on the treatment of aqueous solutions of hydrazine (H), monomethylhydrazine (MMH), and unsymmetrical dimethylhydrazine (UDMH) by ozone. A parametric study was conducted to evaluate the effect of solution concentration and pH, the two catalysts ultraviolet (UV) light and ultrasonics, reactor inlet ozone gas phase concentration and superficial gas velocity. The objectives of this research were (1) to establish the stoichiometry and kinetics of the ozone oxidation of H, MMH, and UDMH in aqueous solution; (2) to identify the partial oxidation products from the ozone oxidation of hydrazine fuels; (3) to accomplish toxicity testing of the ozone treated wastewaters with fathead minnows and Daphnia magna.

SOLID WASTE FUELS

REFER ALSO TO CITATION(S) 11581

HYDRO ENERGY

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 11628, 12001

11423 (DOE/ID/01779—1) **Johnson Lake inlet low-head hydroelectric project. Feasibility assessment report.** (CH2M Hill, Corvallis, OR (USA)). Feb 1979. Contract EW-78-F-07-1779. 33p. Dep. NTIS, PC A03/MF A01.

The feasibility of a low-head hydroelectric plant at the Johnson Lake Inlet Structure, a water level control dam in Nebraska was evaluated. On the basis of technical, economic, legal, and environmental studies it was concluded that the project has a benefit-cost ratio of less than one, and is therefore not economically feasible and further study is not recommended. (LCL)

11424 (PB—295782) **Assessment of hydropower restoration and expansion in new york state. volume i.** Brown, R.S.; Goodman, A.S. (Polytechnic Inst. of Brooklyn, NY (USA)). Aug 1978. 90p. NTIS, PC A05/MF A01.

The study of the potential for the development of small scale hydropower indicates a potential of 3,000 megawatts of undeveloped capacity at a minimum of 754 sites in New York State. This figure far exceeds all previous estimates. The cost of such development will not be cheap but may well be competitive with new generating capacity either thermal or nuclear. Small hydropower has these added advantages: (1) This technology has the shortest time frame for implementation; (2) Environmental impact will be minimal; and, (3) Socio-economic impact will be positive.

SOLAR ENERGY

REFER ALSO TO CITATION(S) 12069

11425 (TAC-STHC—79-002) **Solar thermal heating and cooling: a bibliography with abstracts. Quarterly update, April-June 1979.** (New Mexico Univ., Albuquerque (USA). Technology Application Center). Aug 1979. 213p. Univ. of New Mexico, Albuquerque, NM.

This bibliography contains over 650 citations on various aspects of heating and cooling. (MOW)

11426 Standards and procedures: accreditation of testing laboratories for solar components and systems proposed for permanent adoption: May 17, 1978. Sacramento, CA; California Energy Commission (1978). 44p. (NP—24046).

The criteria and procedures by which the State of California will accredit laboratories to test solar equipment are prescribed. This document describes four laboratory evaluation factors: laboratory organization, human resources, physical resources, and quality systems. Specific requirements, criteria for evaluation, applicable data to be submitted, and the method of assessment for accreditation are also described.

11427 Solar technology inventory for the Mid-American region. Icerman, L. Parker, S.K. (Washington Univ., St. Louis, MO). pp 14-20 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

A mailed questionnaire and telephone contact procedure was developed to identify solar equipment manufacturers in the Mid-American Solar Energy Center (MASEC) region and to collect information required to characterize the solar equipment manufacturing industry. Special emphasis was placed on assembling data that are useful in evaluating the commercialization status of the solar energy industry from an equipment supplier viewpoint.

RESOURCES AND AVAILABILITY

11428 (ATR—79(7747)-2) **Measurements of insolation variation over a solar collector field.** (Aerospace Corp., El Segundo, CA

(USA)). 30 Dec 1978. Contract ET-78-C-03-2028. 68p. Dep. NTIS, PC A04/MF A01.

The experiment described in this report makes observations to determine the direct insolation every 16 sec at corners of a quadrilateral approximately 600 meters in size located near Barstow, California. This size approximates the collector field of the solar power plant to be built near Barstow. Data from the first three months of operation of this experiment indicate cloudy conditions, capable of affecting the operation of a solar power plant, occurred during 15% of the daylight hours of some months. Patterns of insolation variation over the experiment area indicate shadows often exist with dimensions less than the projected size of the collection field for the 10 MW/sub e/ solar thermal power plant. Detailed statistical summaries of four partly cloudy events are included. Rates of insolation change on an individual sensor $\geq 30\ Wm^{-2}\ sec^{-1}$ have been observed, but these rate measurements have probably been limited by the response time of the experimental system. Spatial averaging of the measured insolation over the sensor field lowers the rate of insolation change.

11429 (BNL—50939(2ndEd.)) **Normal incident solar radiation measurements at Upton, New York.** Cottingham, J.G. (Brookhaven National Lab., Upton, NY (USA)). 23 Aug 1979. Contract EY-76-C-02-0016. 14p. Dep. NTIS, PC A02/MF A01.

Normal incident solar energy measurements made at Upton, L.I., New York, are reported and analyzed relative to the total energy received on a horizontal surface. A new method for estimating normal incident solar radiation is developed and used to determine average values for other east coast locations.

11430 (DOE/CS—0126) **Development of an insolation handbook and instrumentation package, Task IV. Final annual progress report.** Riches, M.R. (Department of Energy, Washington, DC (USA). Office of Conservation and Solar Applications). Jan 1980. 28p. Dep. NTIS, PC A03/MF A01.

The objective of this task is to obtain improved basic information for the design and operation of solar heating and cooling systems through better understanding of the required insolation and related weather data, and through improved techniques for measurement and evaluation of such data. A significant and well developed body of knowledge and experience in insolation and related weather measurements exists in national meteorological centers throughout the world. There is, however, a need to summarize this knowledge for valuable and necessary guidance and support to the many developing national solar energy programs. Furthermore, each country should have the means to measure the solar radiation and related parameters in all of its different climatic regions, in regions of forecasted population or industrial growth, and at all potential solar energy utilization sites. Progress is reported on the following subtasks: (A) compilation of a meteorological measurements handbook, and (B) compilation of design and performance specifications for an instrumentation package. (WHK)

11431 (PNL-SA—7317) **Potential contribution of solar energy in the Northwest.** Drumheller, K. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 8 Nov 1978. Contract EY-76-C-06-1830. 12p. (CONF-7811153—1). Dep. NTIS, PC A02/MF A01.

From Thermal power conference; Pullman, WA, USA (8 Nov 1978).

Estimates on the ability of solar energy to supply US energy needs vary from 0 to 25%. It is generally thought that solar can supply as much as we want it to up to 25% in the Northwest by the year 2000 providing an all-out effort is applied now to develop solar energy. The factors affecting the extent of solar utilization are discussed; they are more institutional (inertia, experience, legal, social) than technological or economical. Because of its climate, unique power system, and amount of sunshine, the Northwest is one of the best places in the US for solar energy utilization. Solar energy used in the Northwest is more likely to meet needs that would otherwise be met by new thermal electric plants than is the case in most places.

11432 Determination of the spectral distribution of global radiation with a rapid spectral radiometer and its correlation with solar cell efficiency. Arndt, W.; Bloss, W.H.; Hewig, G.H. (Univ., Stuttgart, Germany). pp 987-994 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

More information about the variation of the spectral distribution of the solar radiation are important for the development and optimization of photovoltaic devices as well as for the planning of solar energy systems. A rapid spectral radiometer covering the range from 250 nm to 2500 nm, which is sufficient for all solar energy application, is described. This apparatus is supplied with an automatic electronic control for ease of use. The calibration of a solar simulator in a test facility for solar cells is described as an example for the employment of the radiometer. The influence of variations of the spectral distribution of global radiation on the output current of solar cells is demonstrated.

11433 Solar connection: promise or peril. Strong, P.S. (Macomb County Community Coll., Warren, MI). pp 367-375 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

During the past decade important progress has been made in understanding the sun-earth environmental system. Modern observations of solar activity document changes in solar output over time scales ranging from seconds to decades, and evidence for longer term variations have been found in historical records. It follows that the sun cannot be considered to be a totally non-variable energy source. Continued research progress into solar-terrestrial interactions will hopefully provide an understanding of sun-weather/climate relationships resulting in energy conservation through more efficient energy utilization of our planet's atmospheric energy system.

ECONOMICS

11434 (DOE/CS/8720—3) **Southwest Project: resource/institutional requirements analysis. Volume III. Systems integration studies.** (Arizona Power Authority, Phoenix (USA); Arizona Public Service Co., Phoenix (USA); El Paso Electric Co., TX (USA); Nevada Power Co., Las Vegas (USA); Stone and Webster Engineering Corp., Boston, MA (USA)). Dec 1979. Contract EM-77-C-01-8720. 128p. Dep. NTIS, PC A07/MF A01.

The purpose of this project is to provide information to DOE which can be used to establish its plans for accelerated commercialization and market penetration of solar electric generating plants in the southwestern region of the United States. The area of interest includes Arizona, California, Colorado, Nevada, New Mexico, Utah, and sections of Oklahoma and Texas. The system integration study establishes the investment that utilities could afford to make in solar thermal, photovoltaic, and wind energy systems, and to assess the sensitivity of the break-even cost to critical variables including fuel escalation rates, fixed charge rates, load growth rates, cloud cover, number of sites, load shape, and energy storage. This information will be used as input to Volume IV, Institutional Studies, one objective of which will be to determine the incentives required to close the gap between the break-even investment for the utilities of the Southwest and the estimated cost of solar generation.

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 11650

11435 (LA-UR—78-474) **Solar heating and cooling working fluids released to the ecosystem.** Wilson, D.W.; Miera, F.R. Jr. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 20p. Dep. NTIS, PC A02/MF A01.

Gylcols, polygloycols, silicone oils, hydrocarbon oils and various corrosion inhibitors and biocides used in solar heating and cooling systems are tested and evaluated for their potential effects on soils, vegetation, and in regard to potential groundwater contamination. Experimental tests include measurement of the effects of additions of these substances to soils on soil microbial respiration, above ground vegetation, and on the mobilization of chemicals in soil water, including the test substance and any significant biodegradation products. Experimental work aims at developing the data base necessary to evaluate the environmental acceptability of the wide range of materials used for this purpose, addressing the need for development of disposal practices and the means of mitigating effects on the environment due to accidental releases.

11436 Arizona solar tax incentives package. Osborn, D.E. (Solar Energy Research Commission, Phoenix, AZ). pp 21-26 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

The State of Arizona has enacted into law one of the nation's most comprehensive and consumer oriented set of tax incentives to encourage the use of solar energy devices. The development of these incentives and their required regulations and guidelines are discussed.

SOLAR ENERGY CONVERSION

REFER ALSO TO CITATION(S) 11421

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 11583, 11621, 11646

11437 **Solar cell module.** Frosch, R.A.; Shepard, N.F. Jr. US Patent 4,162,928. 31 Jul 1979. Filed date 29 Sep 1978. 4p.

A concentrator for a solar cell module for terrestrial use is described. The concentrator employs repeated internal reflection for effective concentration of solar energy onto the active surfaces of the module. Prior techniques for directing solar radiation onto the solar cell surfaces are briefly discussed. The present design provides an improved silicon solar cell module with a zero-depth concentrator. An internally reflective transparent cover plate on the module is described which directs the incident solar energy to the active region without increasing the module depth. 1 claim.

11438 (COO—4094-74) **Comparison of theory and experiment for photovoltaic/thermal collector performance.** Hendrie, S.D. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1980. Contract EY-76-C-02-4094. 7p. (CONF-800106—15). Dep. NTIS, PC A02/MF A01.

From 14. photovoltaics specialists conference; San Diego, CA, USA (7 Jan 1980).

Detailed performance testing of an air and a liquid type combined photovoltaic/thermal (PV/T) collector has been completed with results of accompanying analytical modeling accurately predicting the experimental data. Thermal efficiencies, with concurrent photovoltaic operation at the maximum power point, are computed in accordance with ASHRAE 93-77 specifications and collector-surface heat-transfer coefficients are determined. Analytical modeling of the two collectors from first principals accounts for the non-ideal bonding of photovoltaic cells to the thermal collector components and for the spacing between cells.

11439 (DOE/ET—23044-T1) **Deposition, fabrication and analysis of polycrystalline silicon MIS solar cells. Quarterly technical progress report No. 2, April 1, 1979-June 30, 1979.** Anderson, W.A. (State Univ. of New York, Buffalo (USA). Dept. of Electrical Engineering). 7 Aug 1979. Contract AC03-79ET23044. 40p. Dep. NTIS, PC A03/MF A01.

New information has been obtained about the current conduction in Cr-MIS solar cells by studying their current-voltage relationship over a wide range of temperatures. It is demonstrated that majority carrier tunneling over the combined barrier due to the interfacial oxide and the space charge region, dominates the I-V characteristics at temperatures below 250°K for Cr-SiO/sub x/-(p-Si) solar cells. Insight about the shunt resistance and back contact barrier is also obtained by plotting the activation energy vs applied bias. Majority carriers tunneling via interface states control the characteristics at higher temperatures for these devices, made on 0.4 Ω-cm p-silicon. This information was used in writing a computer-aided design program for use in calculating all losses associated with MIS solar cells. Major loss contributions, other than intrinsic losses, were due to transmission, reflection, the interface, surface states, and grain size in poly-Si. This information was used in fabricating a 13.2% efficient MIS cell on crystalline silicon. Radiation studies involved 1 MeV electron irradiation. Electrical properties of e-beam deposited poly-Si thin films was also considered. Resistivity and conductivity behavior were related to crystallite size and grain boundary trapping effects. (WHK)

11440 (DOE/ET/20408—1) **Heterostructure single crystal silicon photovoltaic solar cells. Final report, September 27, 1976-July 31, 1979.** Szedon, J.R.; Temofonte, T.A.; O'Keeffe, T.W.; Dickey, H.C.; Fonash, S.J.; Sullivan, T.E. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center; Pennsylvania State Univ., University Park (USA)). 31 Jul 1979. Contract EY-76-C-03-1282. 209p. Dep. NTIS, PC A10/MF A01.

The overall objective for this program is the assessment of technical and commercial practicability (specifically, conversion efficiency of 10% or greater at a module selling price below $0.50/peak watt in 1975 dollars) for power generation of metal-heterojunction silicon solar cell of the metal-insulator semiconductor (MIS) variety. Empirical and theoretical studies have been made of cells using both single crystal (n- and p-type) and polycrystalline (p-type) silicon with a variety of metals (Al, Au, Ag, Pd) and silicon dioxide laers of various thicknesses. Performance limitations have been identified. Means to improve cell performance have been evaluated, including material modifications, layer thickness control and changes in device structure. It is concluded that the program goals can be met. Encouraging results in analysis of cells made with polycrystalline material provide a good basis for proceeding with future work to assess the prospects of even lower cost cells.

11441 (DOE/ET/23035—2) **Preparation and characterization of hydrogenated amorphous silicon thin films and thin film solar cells produced by ion plating techniques. Second quarterly progress report, 1 April-30 June 1979.** Cocks, F.H.; Jones, P.L.; Dimmey, L. (Duke Univ., Durham, NC (USA). Dept. of Mechanical Engineering and Materials Science). Sep 1979. Contract AC03-79ET23041. 23p. Dep. NTIS, PC A02/MF A01.

Using quartz substrates, hydrogenated a-Si thin films have now been produced both by glow discharge decomposition of silane and by the controlled ion plating of high purity through glow discharges composed of silane, hydrogen, and argon using a modified Takagi apparatus. Thus far, thin films produced by both glow discharge decomposition of silane with and without magnetic confinement and by ion plating have been characterized and compared using x-ray deffractometry, infrared spectroscopy, optical absorption spectroscopy and by their temperature dependence of resistivity. Based on these results, the ion plating technique of producing a-Si thin films looks extremely encouraging. Films have been produced at approximately ten times the deposition rate obtained using glow discharge decomposition of silane, even with magnetic field containment. In addition the resulting thin film properties measured to date compared favorably with those obtained from our glow discharge produced films and the properties of glow discharge produced films reported in the literature.

11442 (DOE/ET/23044—1) **Deposition, fabrication, and analysis of polycrystalline silicon MIS solar cells. Quarterly technical progress report No. l, January 1, 1979-March 31, 1979.** Anderson, W.A. (State Univ. of New York, Buffalo (USA). Dept. of Electrical Engineering). 27 Jun 1979. Contract AC03-79ET23044. 41p. Dep. NTIS, PC A03/MF A01.

Several areas of research have been addressed in the Technical Discussion. Cr-MIS cells have been fabricated on single crystal and polycrystalline wafers. A one pump-down deposition process now permits deposition of the Cr-Cu-SiO_2 layers in a matter of minutes. Grain boundary effects in polycrystalline substrates have been examined by I-V analysis, laser scan, and interface state studies. A current loss within +- 40 μm of the grain boundary is observed on the average in polycrystalline devices. Polycrystalline substrates exhibit mid-gap interface state density values of $6 \times 10^{11}/cm^2$-eV compared to $3 \times 10^{11}/cm^2$-eV on crystalline substrates. A computer model then was used to verify experimental data showing a decreased V/sub oc/ for interface state density $> 10^{12}/cm^2$-eV or oxide thickness (effective) > 15 A. Proton radiation studies show decreased V/sub oc/, J/sub sc/, and F for fluence levels $> 5 \times 10^{11}/cm^2$. Studies of electron-beam deposited thin silicon films have involved many different sub-topics. The films are deposited on Al coated Ti or stainless steel substrates heated to 400 to 500°C. The deposition rate for a 20 μm thick film is about 2 μm/min. SEM studies have revealed columnar growth. Si growth centers on Al have been clearly revealed. SIMS analysis was used to determine impurity content and doping level. X-ray diffraction studies showed a (110) preferred crystal orientation. The importance of deposition rate and pressure were also revealed. TEM studies revealed crystallites with a 500 A to 5000 A diameter. A new e-beam deposition system is being constructed to attain better vacuum and deposition parameters in an effort to increase crystallite size.

11443 (DOE/JPL/954471—10) **Novel duplex vapor-electrochemical method for silicon solar cells. Quarterly progress report No. 13, 1 February-30 April 1979.** Nanis, L.; Sanjurjo, A.; Sancier, K.; Bartlett, R.; Westphal, S. (SRI International, Menlo Park, CA (USA)). 25 Jun 1979. Contract NAS-7-100-954471. 23p. Dep. NTIS, PC A02/MF A01.

Optimization and scale-up studies of the SiF_4-Na reaction have continued. The dependence of the reaction initiation time and of the efficiency of the reaction on Na particle size and reactor temperature has been studied. Close to 100% utilization of Na has been obtained, and formation of by-product fluosilicate has been decreased to below 10%. A SiF_4-Na reactor has been built to scale-up the reaction by a factor of about 4 and is now being tested. A scaled-up melting system has been built and successfully used to separate Si from kilogram quantities of Si-NaF mixtures. Support studies of the volatilization of NaF performed in a smaller melting system indicated minimal loss of NaF as vapor at 1410°C. The wetting of graphite was also investigated to determine the constituents of the NaF phase which promote good wetting.

11444 (DOE/JPL/954521—1) **Integral glass encapsulation for solar arrays. Interim report No. 2.** Young, P.R. (Spire Corp., Bedford, MA (USA)). Mar 1979. Contract NAS-7-100-954521. 75p. Dep. NTIS, PC A04/MF A01.

This report covers Phase II of a program to develop integral glass encapsulation for solar arrays. The program objective has been to continue the development of electrostatic bonding (ESB) as an encapsulation technique for terrestrial cells. Electrostatic bonding is a process with general applicability to joining metals, semiconductors, and insulators to glass without the aid of adhesives. Elevated temperature is employed to produce ionic conductivity within the glass, while an externally applied electric field is used to move mobile ions near the interface being joined, so that permanent chemical bonding can occur. When applied to solar cell encapsulation this technique works well for either bare silicon cells or those with a variety of antireflective coatings. The advantages of glass as

an encapsulant are numerous; optical clarity, moisture impermeability, chemical and environmental stability, and mechanical strength are just a few. Electrostatic bonding takes full advantage of all the favorable properties of glass. No adhesives, pottants, secondary encapsulants, sealers, or primers are needed to join the cells to the glass. Furthermore, the bond between the cell and glass is stronger than either material. Thus loss of optical coupling or optical transmission is precluded by the use of electrostatic bonding. The project status is reported in detail. (WHK)

11445 (DOE/JPL/954654—2) **Silicon web process development. Low Cost Solar Array Project: Large Area Silicon Test Task. Annual report, April 1978-April 1979.** Duncan, C.S.; Hopkins, R.H.; Seidensticker, R.G.; McHugh, J.P.; Hill, F.E.; Heimlich, M.E.; Driggers, J.M. (Westinghouse Research and Development Center, Pittsburgh, PA (USA)). 1979. Contract NAS-7-100-954654. 231p. Dep. NTIS, PC A11/MF A01.

Silicon dendritic web is a unique mode of ribbon growth in which crystallographic and surface tension forces, rather than shaping dies, are used to control crystal form. The single crystal webs, typically 2-4 cm wide, have been made into solar cells which exhibit AMl conversion efficiencies as high as 15.5%. During crystallization, silicon webs effectively segregate metal impurities to the melt (k/sub eff/ $\sim 10^{-5}$) so that the use of cheaper, less pure silicon as feedstock for crystal growth appears feasible. A research program to significantly increase web output rate and to show the feasibility for simultaneous melt replenishment and growth is described. Also, an economic analysis of the silicon web process is presented. (WHK)

11446 (DOE/JPL/954786—6) **Development of pulsed processes for the manufacture of solar cells. Quarterly progress report No. 4, September 15-December 15, 1978.** (Spire Corp., Bedford, MA (USA)). Jan 1979. Contract NAS-7-100-954786. 55p. Dep. NTIS, PC A04/MF A01.

This report describes the first quarter results under the continuation of a program to develop ion implantation, pulse processes, and the equipment for the automated production of silicon solar cells. The report describes the development status of the process based upon ion implantation for the introduction of junctions and back surface fields. A process sequence is presented employing ion implantation and pulse processing. Efforts to improve throughput and decrease process element costs for furnace annealing are described. Design studies for a modular 3,000 wafer per hour pulse processor are discussed.

11447 (DOE/JPL/954796—6) **Analysis and evaluation in the production process and equipment area of the Low-Cost Solar Array Project. Quarterly report, January-April 1979.** Goldman, H.; Wolf, M. (Pennsylvania Univ., Philadelphia (USA). Moore School of Electrical Engineering). Jun 1979. Contract NAS-7-100-954796. 175p. Dep. NTIS, PC A08/MF A01.

Significant economic and technical data on the current front junction formation processes of Spectrolab's gaseous diffusion, and of involving the Varian-Extrion 200 to 1000 implanter were tabulated, and were used to judge the feasibility of diffusion proposals by Motorola and RCA and ion implantation proposals by Lockheed, Motorola, RCA, and Spire to meet future LSA-JPL guidelines. Cost calculations, consistent with the SAMICS methodology, were performed for the junction formation processes studied.

11448 (DOE/JPL/954822—1) **High efficiency, high density terrestrial panel. Final report.** Wohlgemuth, J.; Wihl, M.; Rosenfield, T. (Solarex Corp., Rockville, MD (USA)). Feb 1979. Contract NAS-7-100-954822. 68p. Dep. NTIS, PC A08/MF A01.

The design and expected performance of large-area close-packed square and rectangular solar cell arrays are described. This includes the basic properties of the solar cells and calculations performed during the design stage and calculations to predict the expected results. A description of the module design, the rationale for, and the specifications of the components to be used in the modules, is given. The test results are given, which includes the results of pre-production humidity and thermal cycling testing, as well as the final test results from measurements both at Solarex and at JPL. An economic analysis of high density panel production, as well as design recommendations and conclusions drawn from this program are included. (WHK)

11449 (DOE/JPL/954853—5) **Array automated assembly. Phase 2. Quarterly report for period ending March 31, 1979.** Taylor, W.E.; Mardesich, N.; Edwards, B.; Bunyan, S.; Garcia, A. (Spectrolab, Inc., Sylmar, CA (USA)). May 1979. Contract NAS-7-100-954853. 35p. Dep. NTIS, PC A03/MF A01.

Research on the technology readiness of a proposed process sequence for the low-cost fabrication of photovoltaic modules is described. Integration of the process sequence using non-textured 2.125 inch square wafers was initiated during this period. Considerable difficulties were encountered requiring process and material modifications. These include: (1) replacement of N-250 spray-on diffusion source with PX-10 source; and (2) modification of the firing cycles for printed silver and printed aluminum contacts is required to accomodate the change of wafer size and shape. Preliminary results from cells processed through the entire process sequence except laser scribe and spray on AR coating indicate that the process sequence is feasible. Indicated cell conversion efficiency is 13 to 15%, however, the process at this point is plagued with low shunt resistance and high series resistance in the cells produced.

11450 (DOE/JPL/954888—T1) **Silicon sheet growth development of the large area silicon sheet task of the Low Cost Silicon Solar Array Project. Fifth quarterly progress report, October 1-December 31, 1978.** Merz, F. (Kayex Corp., Rochester, NY (USA)). 1978. Contract NAS-7-100-954888. 32p. Dep. NTIS, PC A03/MF A01.

The JPL Continuous Czochralski Growth Facility is now essentially complete and is functional. In this reporting period, a silicon lump recharging device was designed; and a prototype was built which performed well in simulated recharge tests. The large chamber (designed to accommodate a 14-inch hot zone) was put into operation initially with the standard hot zone in order to compare performance with previous experience. Some modifications had to be made to the hot zones in the larger chamber due to considerably larger radiative heat losses. Several short (one-ingot) runs were performed and four continuous runs were attempted. The largest continuous run lasted 64 hours and produced 57 kilograms of ingot. The major problem in achieving the 100 kg goal has been difficulty in maintaining high quality (zero dislocation) ingot growth for long periods of time. This may be related to particulate contamination of the melt from the crucible or the hot zone. The previously reported SAMICS analysis was compared with actual experience with regard to recharging. Cost analyses of four possible methods of continuous CZ are included. Spark source mass spectrographic analyses were performed to determine the level of impurity build-up in continuous CZ runs.

11451 (DOE/JPL/954929—4) **Investigation of reliability attributes and accelerated stress factors of terrestrial solar cells. First annual report.** Prince, J.L.; Lathrop, J.W. (Clemson Univ., SC (USA)). May 1979. Contract NAS-7-100-954929. 304p. Dep. NTIS, PC A14/MF A01.

The results of accelerated stress testing of four different types of silicon terrestrial solar cells are discussed. The accelerated stress tests used included bias-temperature tests, bias-temperature-humidity tests, thermal cycle and thermal shock tests, and power cycle tests. Characterization of the cells was performed before stress testing and at periodic down-times, using electrical measurement, visual inspection, and metal adherence pull tests. Electrical parameters measured included short-circuit current, I/sub sc/, open circuit voltage, V/sub oc/, and output power, voltage, and current at the maximum power point, P/sub m/, V/sub m/, and I/sub m/ respectively. Incorporated in the report are the distributions of the prestress electrical data for all cell types. Data was also obtained on cell series and shunt resistance. Significant differences in the response to the various stress tests was observed between cell types. On the basis of the experience gained in this research work, a suggested Reliability Qualification Test Schedule was developed.

11452 (DOE/JPL/954977—6) **Quantitative analysis of defects in silicon: silicon sheet growth development for the Large Area Silicon Sheet Task of the Low-Cost Solar Array Project. Quarterly progress report No. 5, April 1-June 30, 1979.** Natesh, R.; Smith, J.M.; Qidwai, H.A.; Bruce, T. (Materials Research, Inc., Centerville, UT (USA)). 12 Jul 1979. Contract NAS-7-100-954977. 176p. Dep. NTIS, PC A09/MF A01.

During this reporting period a computer program was written for the PDP 11/03 computer that controls the Quantimet 720 Image Analyzing System (QTM 720). This program will facilitate the analysis of silicon samples on the upgraded Quantimet 720 System. Also during this period thirty-two (32) Motorola samples were analyzed for twin boundaries, dislocation pits, and grain boundaries. A discussion of the computer program and the data obtained from the thirty-two (32) Motorola samples are given. The use of the Image Editor on the QTM 720 detected image is also described.

11453 (DOE/JPL/955201—3) **Low cost solar array project: composition measurements by analytical photon catalysts. Third quarterly report, April 1-June 30, 1979.** Sutton, D.G.; Galvan, L.; Melzer, J.; Heidner, R.F. III. (Aerospace Corp., El Segundo, CA (USA). Ivan A. Getting Labs.). 1979. Contract NAS7-100-955201. 21p. Dep. NTIS, PC A02/MF A01.

The object of this research is to assess the applicability of the photon catalysis technique for effecting composition analysis of silicon samples. In particular, the technique is to be evaluated as a detector for the impurities Al, Cr, Fe, Mn, Ti, V, Mo, and Zr. During the first reporting period Al, Cr, Fe, and Mn were detected with the photon catalysis method. The best fluorescence lines to monitor were established and initial sensitivities to each of these elements were determined by atomic absorption calibration. In the course of these tests vapor pressure curves for these four pure substances have also been mapped. During the second quarter Ti and

Si were detected with the technique. The best lines to monitor were catalogued and vapor pressure curves were determined. Attempts to detect vanadium were unsuccessful due to the refractory nature of this element and the limited temperature range of the evaporator. The third quarter was devoted to the study of impurities in silicon matrices. The evaporation process was shown to be congruent; thus, spectral analysis of the vapor will yield the composition of the bulk sample. Qualitative analysis of metal impurities in silicon was demonstrated below the part per million level. Only one atomic spectral interference has been noted so far; however, it is imperative to maintain a leak tight system due to chemical and spectral interferences caused by the presence of even minute amounts of oxygen in the active nitrogen afterglow.

11454 (DOE/JPL/955278—2) **Automated solar panel assembly line. LSA task: production processes & equipment. Quarterly report No. 2.** Somberg, H. (ARCO Solar, Inc., Chatsworth, CA (USA)). 8 Jul 1979. Contract NAS-7-100-955278. 16p. Dep. NTIS, PC A02/MF A01.

The objective of this program is to design, fabricate and demonstrate an automated solar cell module production line with the ultimate goal of reducing module assembly costs. During this reporting period a redesign of the SCAP soldering mechanism was effected due to temperature/friction problems encountered. The in-line cleaning system was designed and ordered and the Mular backbone attachment mechanism was assembled. The SPLP production prototype was fabricated and operated. Two hand-assembled versions of the automated module design completed 750 thermal cycles. Albuquerque Laboratory, Ardev Inc., is under subcontract to develop the soldering equipment on this program. The lamination development is being done by ARCO Solar, Inc.

11455 (DOE/JPL/955287—2) **Automated solar module assembly line. Quarterly technical report No. 2.** Bycer, M. (Kulicke and Soffa Industries, Inc., Horsham, PA (USA)). Jun 1979. Contract NAS-7-100-955287. 20p. Dep. NTIS, PC A02/MF A01.

Progress during this period is reported including the work performed in bonding interconnects with induction heating and prototype designs for the conveyor, theta orient station, and vacuum pick-up and lance assemblies. The machine which Kulicke and Soffa is to deliver under this contract is a cell stringing and string applique machine which will be flexible in design, capable of handling an variety of cells and assembling strings of cells which can then be placed in a matrix up to 2' x 4' in series or parallel arrangement. The target machine cycle is to be 5 seconds per cell. This machine will be primarily adapted to 100 m round cells with one or two tabs between cells. The design of the machine will be flexible so that it can be modified to handle other cell sizes, string lengths and module arrangements.

11456 (DOE/NASA/CR—150696) **Survey of photovoltaic systems.** (Alabama Univ., Huntsville (USA)). Aug 1979. Contract EX-76-A-29-1037;EG-77-S-05-5362. 224p. Dep. NTIS, PC A10/MF A01.

In developing this survey of photovoltaic systems, the University of Alabama in Huntsville assembled a task team to perform an extensive telephone survey of all known photovoltaic manufacturers. Three US companies accounted for 77% of the total domestic sales in 1978. They are Solarex Corporation, Solar Power Croporation, and ARCO Solar, Inc. This survey of solar photovoltaic (P/V) manufacturers and suppliers consists of three parts: a catalog of suppliers arranged alphabetically, data sheets on specific products, and typical operating, installation, or maintenance instructions and procedures. This report does not recommend or endorse any company product or information presented within as the results of this survey.

11457 (N—79-16354) **Study of solar cell welds. Final report.** Workman, G.L. (North Alabama Scientific and Engineering Consultants, Inc., Huntsville (USA)). 7 Nov 1978. Contract NAS8-33077. 30p. NTIS, PC A03/MF A01.

The thermal imaging technique was evaluated for its capabilities in the nondestructive evaluation of solar cell welds. The temperature and spatial resolution of state of the art instrumentation was sufficient for both qualitative and quantitative determination of the quality of solar cell welds. The addition of color digitized thermography enhanced the aspects of the thermographic display and allowed easily computerized testing procedures. For automated testing systems an accurate correlation of weld quality with temperature profiles of the welds needs to be performed. In comparison, the holographic technique was complementary with the thermal imaging technique, except that the holographic analysis appeared to be more quantitative at the present time. However, the thermal imaging approach is much more versatile in overall capabilities.

11458 (N—79-16367) **Low Cost Solar Array Project: composition measurements by analytical photon catalysis. Quarterly report, 1 November-31 December 1978.** Sutton, D.G.; Galvan, L.; Melzer, J.; Heidner, R.F. III. (Aerospace Corp., El Segundo, CA (USA). Ivan A. Getting Labs.). 1978. Contract NAS7-100. 25p. NTIS, PC A02/MF A01.

The applicability of the photon catalysis technique for effecting composition analysis of silicon samples is assessed. In particular, the technique is to be evaluated as a detector for the impurities Al, Cr, Fe, Mn, Ti, V, Mo and Zr. During the first reporting period Al, Cr, Fe and Mn were detected with the photon catalysis method. The best fluorescence lines to monitor and determined initial sensitivities to each of these elements by atomic absorption calibration were established. In the course of these tests, vapor pressure curves for these four pure substances were mapped.

11459 (N—79-16368) **Evaluation of the technical feasibility and effective cost of various wafer thicknesses for the manufacture of solar cells. Quarterly progress report, 15 July 1978-30 September 1978.** (Solarex Corp., Rockville, MD (USA)). 1978. Contracts JPL-955077;NAS7-100. 26p. NTIS, PC A03/MF A01.

Three wafering demonstration runs were completed on the Yasunaga wire saw. Wafer thickness/taper uniformity is excellent. Many small problems were encountered with Yasunaga accessories, slowing the effort. A wafer characterization cycle was defined and will be initiated during the next period.

11460 (N—79-16369) **Continuous Czochralski growth: silicon sheet growth development of the Large Area Silicon Sheet Task of the Low Cost Silicon Solar Array Project. Annual progress report, 1 October 1977-30 September 1978.** (Kayex Corp., Rochester, NY (USA)). 1978. 54p. NTIS, PC A04/MF A01.

The primary objective of this contract is to develop equipment and methods for the economic production of single crystal ingot material by the continuous Czochralski (CZ) process. Continuous CZ is defined for the purpose of this work as the growth of at least 100 kilograms of ingot from only one melt container. During the reporting period (October 1977-September 1978), a modified grower was made fully functional and several recharge runs were performed. The largest run lasted 44 hours and over 42 kg of ingot was produced. Little, if any, degradation in efficiency was observed as a result of pulling multiple crystals from one crucible. Solar efficiencies observed were between 9.3 and 10.4% AMO (13.0 and 14.6% AMI) compared to 10.5% (14.7% AMI) for optimum CZ material control samples. Using the SAMICS/IPEG format, economic analysis of continuous CZ suggests that 1986 DOE cost goals can only be met by the growth of large diameter, large mass crystals.

11461 (N—79-16379) **Study on solar arrays for programmes leading from the extension of spacelab towards space platforms. Final report.** Gillett, P.R.C. (British Aerospace Dynamics Group, Bristol (UK)). Jun 1978. Contract ESA-3404/77-F-HEW(SC). 98p. NTIS, PC A05/MF A01.

A description of the major requirements of a set of candidate missions is presented and some preliminary solar array designs are given. A development strategy is outlined and the principal areas of new technology identified.

11462 (N—79-19452) **A theoretical study of heterojunction and graded band gap type solar cells. Final report.** Chiang, J.P.C.; Hauser, J.R. (North Carolina State Univ., Raleigh (USA). Dept. of Electrical Engineering). Mar 1979. 51p. NTIS PC A04/MF A01.

The work performed concentrated on including multisun effects, high temperature effects, and electron irrradiation effects into the computer analysis program for heterojunction and graded bandgap solar cells. These objectives were accomplished and the program is now available for such calculations.

11463 (N—79-19458) **Studies of silicon pn junction solar cells. Final technical report.** Lindholm, F.A.; Neugroschel, A. (Florida Univ., Gainesville (USA). Dept. of Electrical Engineering). Sep 1977. 88p. NTIS PC A05/MF A01.

Modifications of the basic Shockley equations that result from the random and nonrandom spatial variations of the chemical composition of a semiconductor were developed. These modifications underlie the existence of the extensive emitter recombination current that limits the voltage over the open circuit of solar cells. The measurement of parameters, series resistance and the base diffusion length is discussed. Two methods are presented for establishing the energy bandgap narrowing in the heavily-doped emitter region. Corrections that can be important in the application of one of these methods to small test cells are examined. Oxide-charge-induced high-low-junction emitter (OCI-HLE) test cells which exhibit considerably higher voltage over the open circuit than was previously seen in n-on-p solar cells are described.

11464 (N—79-19459) **Development of an improved high efficiency thin silicon solar cell. Quarterly report.** Wrigley, C.; Storti, G. (Solarex Corp., Rockville, MD (USA)). Jul 1978. Contracts NAS7-100;JPL-954883. 10p. NTIS PC A02/MF A01.

Efforts were directed towards investigating means of producing more effective high-low junctions at the back of the cell. Cells with output power up to 77 mW (AM0 efficiency of 14.2 percent)

were fabricated. Some reflectivity studies were also made. Deliveries of 2 cm x 2 cm experimental cells included a number having AM0 outputs greater than 70 mW.

11465 (PB—290940) **Investigation of low cost solar cells based on Cu_2O. Final report, 1 September 1975-30 June 1978.** Olsen, L.C. (Joint Center for Graduate Study, Richland, WA (USA). Solar Energy Lab.). Sep 1978. 86p. NTIS, PC A05/MF A01.

Research conducted over a three-year period to investigate solar cells based on cuprous oxide is summarized. Cell studies have been carried out with cuprous oxide substrates grown by complete oxidation of copper discs. Oxidation typically is carried out at 1050 degrees Centigrade in dry air. Cuprous oxide grown in this manner is p-type with a resistivity in the range of 2000 to 4000 ohm-centimeters. An approach was developed for doping cuprous oxide with magnesium and chlorine to achieve material with a resistivity in the one to ten ohm-centimeter range. Frontwall cell structures studies included Schottky barriers, metal-insulator-semiconductor (MIS) devices and heterojunctions. Schottky barriers made with various metals essentially all exhibit a barrier height of 0.7 to 0.9 eV. Surface analyses conducted using Auger and electron spectroscopy indicate that most metals reduce cuprous oxide, thus forming a copper-rich metal layer. MIS cells were made with numerous interfacial layers. Heterojunction studies involved zinc sulfide/cuprous oxide and zinc oxide/cuprous oxide. Difficulties were encountered in depositing the zinc oxide and the zinc sulfide films to be transparent and conducting. Encouraging results were obtained for zinc sulfide/cuprous oxide cells.

11466 (PB—298168) **Polycrystalline thin film gallium arsenide solar cells. Final report.** Borrego, J.M.; Ghandhi, S.K. (Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Electrical and Systems Engineering). 30 Sep 1978. 62p. NTIS, PC A04/MF A01.

The objective of this program was to demonstrate the feasibility of solar cells made on a metallic substrate, using polycrystalline thin film GaAs and an upper layer of a highly conductive wide gap material such as doped tin oxide. The program has established the feasibility of making cells of this type, and has outlined problems encountered during the high temperature growth of the upper layer. In addition, room temperature growth of tin oxide has been achieved for the first time. Techniques have been developed for optical characterization of the transparent layer. Deep level transient spectroscopy methods have also been developed to aid in the improvement of the polycrystalline layer. Other accomplishments include the development of a technique for measuring diffusion length in direct gap materials, the fabrication of GaAs-Ge-Mo diodes with a BV of 35 volts, and a technique for the passivation of the grain boundary edge, which results in greatly increasing the open circuit voltage.

11467 (SAN—1282-6) **Heterostructure single crystal silicon photovoltaic solar cells. Sixth quarter report, January 1, 1978-March 31, 1978.** Szedon, J.R.; Temofonte, T.A.; O'Keeffe, T.W.; Fonash, S.J. (Westinghouse Research and Development Center, Pittsburgh, PA (USA); Pennsylvania State Univ., University Park (USA)). 11 Oct 1978. Contract EY-76-C-03-1282. 26p. Dep. NTIS, PC A03/MF A01.

The use of scanned laser (6330A) spot excitation of MIS cells has allowed estimation of grain boundary geometry effects on V/sub OC/ and I/sub SC/ of cells prepared on polycrystalline silicon substrates. Cells on polycrystalline material prepared by Czochralski and dendritic web growth methods have been studied. Photocurrent suppression, by grating boundary recombination mechanisms, of about 3% was estimated for excitation at the laser wavelength for both materials. Details of total grain boundary length, width of the affected region and local strength of the suppression were different for the two cases. Bucking current density (assumed normal to the boundary walls cutting through the wafer) values were estimated to be 40 to 80% of those of the usual bucking current normal to the illuminated surface. Gold Schottky barrier and MIS cells on n-substrates exhibit barrier height and open circuit voltage sensitivity to details of the silicon etch preceding metallization or oxidation. TEM studies established that thin silver films on oxidized silicon surfaces show greater agglomeration (accounting for higher sheet resistance) than films of comparable thickness on bare silicon surfaces.

11468 (SAN—1282-7) **Heterostructure single crystal silicon photovoltaic solar cells. Seventh quarterly report, April 1-June 30, 1978.** Szedon, J.R.; Temofonte, T.A.; Dickey, H.C.; Hoffmann, R.A.; Blankenship, B.A.; O'Keeffe, T.W.; Fonash, S.J. (Westinghouse Research and Development Center, Pittsburgh, PA (USA); Pennsylvania State Univ., University Park (USA)). 1 Nov 1978. Contract EY-76-C-03-1282. 40p. Dep. NTIS, PC A03/MF A01.

A number of approaches have been explored to improve the short circuit current-fill factor product of Al-SiO_2-pSi cells from the point of view of the trade-off between optical transmission into the silicon and series resistance contribution from the high sheet resistance components of the cell. The approaches have involved material modification (evaporating aluminum in an oxygen containing ambient to improve transmission), partitioning the cell surface between alternate strips of metal (thin or thick) and bare silicon having an inversion layer and illuminating a carefully designed cell on the surface opposite that bearing the MIS collecting barrier. Experimental cells with comparable efficiency have been made with all four approaches. Details of cell operation and models for performance have been examined carefully. The inversion layer cell (with narrow opaque metal strips providing an MIS contact to an inversion layer over the full illuminated cell surface) is the most promising of the conventional approaches. The back illuminated cell with a BSF region is very attractive from standpoints of environmental stability, performance optimization and applicability of thin polycrystalline silicon films. Work at Penn State has established that the Al-SiO_2-pSi cell is bulk diffusion controlled in dark current behavior and stores charge within the thin SiO_2 layer.

11469 (SAN—1284-T2) **Gallium arsenide thin films on tungsten/graphite substrates: Phase II. Final report, September 1, 1977 to November 30, 1978.** Chu, S.S. (Southern Methodist Univ., Dallas, TX (USA)). Nov 1978. Contract EY-76-C-03-1284. 68p. Dep. NTIS, PC A04/MF A01.

The objectives of this contract are to investigate thin films of gallium arsenide on low cost substrates and to prepare solar cells with an AM1 efficiency of 6% or higher by August 1978. Efforts during this year have been directed to (1) the deposition and characterization of gallium arsenide films on tungsten/graphite and graphite substrates, including the initial stage of the deposition process, (2) the effects of the addition of hydrogen chloride to the reactant mixture on the microstructure of gallium arsenide, (3) the deposition of titanium dioxide films as antireflection coatings, (4) the fabrication and characterization of gallium arsenide solar cells on tungsten/graphite and graphite substrates, and (5) the investigation of the temperature coefficients and stabilities of thin film gallium arsenide MOS solar cells. Results are reported. (WHK)

11470 (SAN—1285-T1) **Thin films of silicon on metallurgical silicon substrates. Phase II. Quarterly project report, March 1-May 31, 1978.** Chu, T.L. (Southern Methodist Univ., Dallas, TX (USA)). Jun 1978. Contract EY-76-C-03-1285. 32p. Dep. NTIS, PC A03/MF A01.

The objectives of this contract are to investigate thin films of silicon on metallurgical silicon substrates and to demonstrate an AM1 efficiency of 10% for large area (30 cm^2) thin film silicon solar cells by August 1979. Efforts during the past quarter have been directed to the purification of metallurgical silicon, the preparation of substrates, the fabrication and characterization of solar cells, the reduction of grain boundary effects, and preliminary investigations of the stability of thin film polycrystalline silicon solar cells. The use of the acid extraction and phosphorus pentoxide treatment techniques for the removal of iron from metallurgical silicon has been continued. Metallurgical silicon purified by both techniques has been used to prepare substrates for the deposition of the active region of solar cells. Solar cells of 9 cm^2 area have been prepared from planar substrates recrystallized from acid-extracted and phosphorus pentoxide treated metallurgical silicon. The heat treatment of the deposited solar cell structures has been found to be essential to obtain good characteristics. Using chemically deposited tin-dioxide films as antireflection coatings, the best cell has an AM1 efficiency of 9.5% at room temperature. Preliminary work on the effects of thermal and optical stress on the characteristics of thin film polycrystalline silicon solar cells indicates that they are stable under conditions for terrestrial applications.

11471 (SAN—1458-3) **Cadmium sulfide/copper ternary heterojunction cell research. Quarterly technical progress report, April 1-June 30, 1978.** Mickelsen, R.; Selikson, B.; Chen, W. (Boeing Aerospace Co., Seattle, WA (USA)). Jul 1978. Contract EG-77-C-03-1458. 15p. Dep. NTIS, PC A02/MF A01.

The objective of this research program is the development of a thin-film photovoltaic solar cell based upon a cadmium sulfide/copper ternary compound heterojunction materials system. The ternary material is chalcopyrite $CuInSe_2$ formed by simultaneous elemental evaporation. The research effort has concerned the preparation and characterization of $CuInSe_2$ and CdS films and the fabrication and testing of 1 cm^2 area CdS/$CuInSe_2$ heterojunction thin-film devices. A modification to the vapor beam homogenization chamber structure used to deposit the selenide films is described. The successful modification was made to prolong the operational lifetime of the chamber without sacrificing deposited film uniformity. Grain size of $CuInSe_2$ is reported to be small ($\sim$ 0.5 μm) even for films subjected to relatively high processing temperatures. Doping the CdS film during growth with indium is described as an effective means for reducing the CdS resistivity and this contribution to the cell series resistance. Measurements are given indicating resistivities as low as 0.003 Ω-cm. I-V curves for fabricated cells are presented showing two types of cell behavior. Type 1 has high open circuit voltages and low short circuit currents while Type 2 possesses the reverse characteristics. Maximum values are given as 0.33 V, 23 mA/cm^2, and 2% efficiency under simulated 100 mW/cm^2 illumination.

11472 (SAN—2219-2) **Amorphous thin films for solar-cell applications. Quarterly report No. 2, December 12, 1978 to March 11, 1979.** Carlson, D.E.; Balberg, I.; Crandall, R.S.; Hanak, J.J.; Pankove, J.I.; Staebler, D.L.; Weakliem, H.A. (RCA Labs., Princeton, NJ (USA)). Apr 1979. Contract ET-78-C-03-2219. 47p. Dep. NTIS, PC A03/MF A01.

The present research program involves five tasks: theoretical modeling, deposition and doping studies, experimental methods for the characterization of a-Si:H, formation of solar-cell structures, and theoretical and experimental evaluation of solar-cell parameters. In the section on theoretical modeling, a theory for the quantum efficiency to produce free electron-hole pairs in hydrogenated amorphous silicon (a-Si:H) is presented. Recent results obtained with the rf magnetron deposition system are reported. Experimental results are included that show the deleterious effect of adding either helium or hydrogen to an SiH_4 discharge. Other experiments have shown that adding SiF_4 to SiH_4 discharges decreases the photoluminescence intensity of the a-Si:H:F films. Experimental results for the band mobilities, minority-carrier diffusion lengths ($\sim$ 0.05 to 0.18 μm), and density of defect states are given. Information about the density of gap states has been obtained from measurements of the photoconductivity and from tunneling measurements. Information on some optimized fabrication parameters for inverted p-i-n cells is given. Also, the theoretical and experimental evaluation of solar-cell parameters is discussed. The breakdown voltage of p-i-n cells has been investigated, and a degradation has been observed in these cells after forward biasing to +3 V. The degradation of Pd-Schottky-barrier cells is due to the diffusion of Pd as well as OH groups into the a-Si:H.

11473 (SAND—79-1781) **Extrinsic losses in solar cells for linear focus systems.** Garner, C.M. (Sandia Labs., Albuquerque, NM (USA)). Dec 1979. Contract EY-76-C-04-0789. 42p. Dep. NTIS, PC A03/MF A01.

Solar cell efficiency is dependent on the intrinsic one-dimensional diode efficiency and on the extrinsic losses (i.e., contact shadowing, series resistance and losses arising from nonuniform illumination). These extrinsic losses can depend on cell size and should be considered in the design of concentrator systems. The carrier transport and junction phenomena are arbitrarily called intrinsic effects, and the efficiency resulting from the one-dimensional transport equations will be called the intrinsic efficiency. The effects under consideration will be called extrinsic effects. The I^2R and shadowing losses have been calculated as a function of cell size, contact thickness and number of buses. In addition, losses resulting from nonuniform illumination and temperature have been calculated. These results should give clear guidelines for the design of receivers for linear focus systems.

11474 (SAND—80-0143C) **Photovoltaic concentrators.** Boes, E.C. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 10p. (CONF-800106—7). Dep. NTIS, PC A02/MF A01.

From 14. photovoltaics specialists conference; San Diego, CA, USA (7 Jan 1980).

A status report on photovoltaic concentrators technology is presented. The major topics covered are as follows: (1) current PV concentrator arrays: designs, performances, and costs; (2) current PV concentrator array components; cells and cell assemblies, optical concentrators, support structures, tracking, and drive; (3) design of PV concentrator arrays; and (4) array manufacturing technology. (WHK)

11475 **Luminescent solar collector.** Yerkes, J.W. (to Atlantic Richfield Co.). US Patent 4,159,212. 26 Jun 1979. Filed date 18 Sep 1978. 6p.

A luminescent solar collector is described that contains at least one luminescent member having a pair of opposed surfaces and at least one photovoltaic means embedded in the luminescent member. It extends from one of said surfaces to the opposing surface of the luminescent member. 9 claims.

11476 **Solar energy window.** Field, R.L. US Patent 4,137,098. 30 Jan 1979. Filed date 20 Oct 1977. 4p.

This patent describes an energy absorbing venetian blind type device for generating electricity, providing heat, and serving as a sun shade. A plurality of slats covered with an array of photovoltaic cells are enclosed between two panes of glass of a window housing. A heat removal system using forced air cools the photovoltaic cells and collects heat for heating purposes elsewhere. The electricity generated by the photovoltaic cells is collected for immediate use or storage batteries for later use.

11477 **Improved analysis of the N-type Schottky barrier solar cell.** Klimpke, C.M.H.; Landsberg, P.T. (Univ. of Southampton, England). pp 678-681 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovoltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

By discarding the depletion approximation and the assumption of constant Fermi levels the actual shape of these levels has been computed for a Schottky barrier solar cell we believe for the first time. Additional improvements of the theory deal with (a) the dependence of the barrier height on the density of interfacial states and they also deal with the various potential drops in the cell, and (b) the allowance for the communication between metal and interfacial surface states in the treatment of recombination through the interfacial states. The work is too extensive to be presented here in full. Therefore only some results of the theoretical computation of band edges and Fermi levels are shown.

11478 **Recent advances in solar silicon purification technology.** Ingle, W.M. (Motorola Inc., Phoenix, AZ). pp 702-709 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovoltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

In late 1975, major funding was initiated by the US Department of Energy for development of low cost silicon solar cells for photovoltaic energy conversion. The increased interest resulted in new chemical processes for producing high purity silicon at a low cost. On the other hand, increased silicon consumption by semiconductor device manufacturers has rapidly approached a critical crossover point where more high purity silicon will be consumed than produced. Consequently, solar cell manufacturers are exploring additional sources of semiconductor grade Si. The arc reduction process currently being investigated by Westinghouse could supply technology for a low cost silicon process in the near term. By 1981 or 1982 low cost silicon production processes under investigation at Union Carbide Corporation or at Battelle Columbus Laboratories could materialize. In the same time frame, R and D efforts from SERI funding (RFP No. RS-9-8119) and alternate in house R and D projects at semiconductor manufacturer and petrochemical companies could develop technologies for low cost silicon. Due to the long lead times (3 to 5 years) needed to design, build, and turn on large size poly plants it is unlikely that these projects will have any impact on the expected poly shortage in 1980 to 1984.

11479 **Some characteristics of low-cost silicon sheet.** Koliwad, K.M.; Daud, T.; Liu, J.K. (California Inst. of Tech., Pasadena). pp 710-717 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovoltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

It is well recognized by now that the cost of silicon sheet has to be substantially reduced in order to meet the requirements of low-cost terrestrial solar photovoltaic arrays. Several novel and potentiall low-cost silicon sheet growth technologies are currently being developed in the United States. The resulting silicon sheet differs from that produced for semiconductor integrated circuit applications. The low-cost silicon sheet is structurally and chemically less perfect. These imperfections are the direct result of the growth processes, which are classified as ingot and shaped sheet categories. Characteristics of sheet growth processes are presented. The various structural defects generally present in the low-cost silicon sheet and their influence on the electronic properties salient to solar cell performance are discussed. Experimental data on the effect of grain-boundaries upon minority carrier diffusion length, impurity defect interaction, and variable surface recombination velocity are presented. Based on these results an analytical model of the effect of grain-boundaries on solar cell performance is discussed.

11480 **Low cost processes for silicon.** Lutwack, R. (California Inst. of Tech., Pasadena). pp 718-725 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The task program, which began in 1975, uses a multiple process development approach. The effects of impurities on the performance of solar cells are also being investigated to assess the need for purification units. A support program includes subtasks for the modelling of reactions and reactors, for chemical engineering and solid state physics studies, and for developing impurity concentration measurement procedures. The developments by Battelle and Union Carbide are the most advanced; the program-phase for Experimental Process System Development Units (EPSDU) is next, most of the data for the chemical reactions and chemical engineering having been obtained. The present phase involves the process and detailed engineering designs required for the installation of the EPSDU. Studies to optimize reactor design and unit operating conditions are being performed concurrently. The preliminary economic analyses have given total product costs (based on 1000 MT/year plants and 1975 dollars) of $7.28 to $8.73/kg for Battelle and $5.00 to 6.90/kg for Union Carbide. Other processes are also being

developed. In the studies of impurity effects a model based on the premise that degradations of solar cell performance by impurities are primarily due to decreases in base diffusion length was derived from extensive experimental data. The effects of specific impurities and cell-processing steps were determined. An acceptable impurity content depends on specifications for cell efficiency, crystal growth method, melt replenishment, and cell processing steps.

11481 Effects of boron and phosphorus primary impurities in p-type silicon material for solar cells. Giarda, L. (Istituto G. Donegani Montedison, Novara, Italy); Parisi, A.; Pizzini, S.; Finetti, M.; Negrini, P. pp 726-733 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The aim of this work was to investigate the effects of boron and phosphorus primary impurities on silicon solar cell performance. 0.5 to 2 ohm-cm, p-type silicon crystal ingots were grown with contemporary doping of B and P at various levels in the 0.1 to 10 ppmw range. Solar cells fabricated on this material were characterized by current-voltage and diffusion length measurements. It is shown that the minority carriers mobility and lifetime are apparently related to the sum of boron and phosphorus concentrations. Furthermore, a total content of impurities up to 1 to 2 x 10^{17} at/cm^3 can be tolerated without any significative degradation in photovoltaic conversion efficiency.

11482 Recrystallization of C.V.D. grown polycrystalline silicon and the influence of dopants on grain growth. Schins, W.J.H.; Bezemer, J.; Radelaar, S. (State Univ. of Utrecht, Netherlands). pp 734-741 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Polycrystalline C.V.D.-grown silicon with a grain size of less than 10 μm can be recrystallized to larger grains at temperatures between 1200 and 1420°C. A primary matrix is obtained with a very inhomogeneous grain size. Grains are 50 μm average in size and further grain growth does not occur, even after prolonged heating. However, by introduction of boron or aluminium in the material via a gaseous phase, grain growth occurs with a resulting grain size of a few hundreds of micrometers. Whether these processes occur via a liquid phase boundary or by an intrinsic diffusion enhancement is not clear yet. In the case of boron doping sometimes SiB_4 precipitates are found. These processes offer possibilities to induce grain growth at high temperatures in polycrystalline silicon doped simultaneously with boron during C.V.D.-growth.

11483 Polycrystalline silicon and its characterization. Helmreich, D. (Heliotronic GmbH, Burghausen, Germany); Seiter, H. pp 742-749 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A detailed comparative study of defect states in different forms of melt- and vapor-grown silicon showed that it is possible to characterize the solar cell base material with respect to structural defects and chemical impurities and their synergistic effects on device performance. For investigating defect states, etching techniques were combined with electrical, optical, and electron beam characterization. Impurity contents and segregation have been evaluated by means of various solid state methods.

11484 Transport properties and TEM observation of RAD polycrystalline silicon films. Johan, A. (C.E.S.R., Toulouse, France); Ayerza, J.; Bielle-Daspet, D.; Rocher, A.; Fontaine, C. pp 750-758 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

P-type samples grown from 1 Ω.cm silicon on carbon or carbon-like substrate are studied. Using steady-state measurements and transient photoresponses, conduction I(V), conductivity pμ/sub p/, Hall density p/sub H/, mobilities μ/sub p,Hp,n/ and decay-time constants tau/sub p,n/ of majority and/or minority carriers are compared (carbon substrate material). The variations with temperature, polychromatic steady state excitation p/sub chi e/ and transient excess carrier density Δ = 10^{12} to 10^{20} cm^{-3} (from 1.06 μm laser excitation) are used to analyze the results. The samples studied show low average potential barrier (phi/sub B/ = 0.15 eV). The majority carrier properties I(V), p/sub H/, μ/sub pH/, pμ/sub p/ appear to vary from sample to sample more than the minority carrier ones μ/sub n, tau/sub n/ do. The effects of traps, donor and acceptor centers, and the annealing stages observed suggest that residual impurities and point defects take important part in these variations. The preliminary results concerning the TEM observation of defects in such samples indicate that: most grain boundaries can be characterized by twin relationships. Classical twins (first order) are observed. Some interfaces are free of dislocations. Other have 10^4/cm or more dislocations in the plane of the interfaces. Second, third, and fifth order twin relationship are also observed. The interfaces are not plane and contain steps and dislocations; precipitates of silicon carbide have been observed as dendrite in the silicon layers near the substrate.

11485 Growth of polycrystalline silicon layers on top of a tin-coated substrate: in situ observations. Bloem, J.; Giling, L.J.; Graef, M.W.M.; De Moor, H.H.C. (Catholic Univ., Nijmegen, Netherlands). pp 759-766 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The growth of silicon onto tin-coated graphite (CVDOLL process; chemical vapor deposition on liuqid layers) leads to the formation of large-grain polycrystalline silicon films. This process was subjected to in situ observations, which showed that: after melting, the tin layer contracts into droplets, which spread out again if a small amount of silicon is introduced in the gas phase. This is due to a reduction of the surface tension when silicon dissolves into tin; the initial growth of silicon proceeds essentially according to a vapor-liquid-solid mechanism - silicon is dissolved in tin, and is precipitated due to supersaturation of the solution; the silicon growth is accompanied by the simultaneous evaporation of tin. The latter is a function of temperature and HCl pressure; after the completion of tin evaporation, the grain boundaries are formed - these propagate in a vertical direction.

11486 Improvement of phosphorus diffused silicon solar cells by laser treatment. Fogarassy, E. (Centre de Recherches Nucleaires. Strasbourg, France); Stuck, R.; Muller, J.C.; Grob, A.; Grob, J.J.; Siffert,P.; Salles, Y.; Diguet, D. pp 768-775 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, J.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The most widely used technology for the production of silicon cells is the diffusion of phosphorus into a P-type substrate. However, by this technique, it is nearly impossible to decrease the surface sheet resistance below 35 Ω/cm^2 without degrading too much the spectral sensitivity of the cell. This is due to the fact that the concentration of electrically active phosphorus which can be introduced by diffusion is limited to 4 x 10^{20} cm^{-3} whereas the total phosphorus concentration may be higher than 10^{21} cm^{-3}. In this work it is shown that this inactive excess can be partly reactivated by irradiation with short ruby laser pulses of high energy (≃ 1 J/cm^2) which melt the surface of silicon. By this technique sheet resistances as low as 15 Ω/cm^2 could be obtained. A systematic study of this effect and of the influences of the diffusion and irradiation conditions has been performed using SIMS, RBS, electrical and optical methods. An interpretation of the phenomenon in terms of dissolution of precipitates and dissociation of phosphorus vacancies pairs P^+V^{2-}/ is proposed. The influence of this treatment on solar cells has also been investigated. A significant increase (≃ 20 mV) of the open circuit voltage has been observed and the efficiency of cells supplied by RTC cell could be improved by about 10%.

11487 Influence of the double exponential on the efficiency and the yield of screen printed solar cells. Lauwers, P.; Frisson, L.; Janssens, R.; Mertens, R.; Govaerts, R.; Van Overstraeten, R. (Katholieke Univ. Leuven, Heverlee, Belgium). pp 776-783 of 2nd E.C. photovolatic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

As a result of previous work, a metallization process for silicon solar cells using screen printing has been obtained. The cells made by this process have average efficiencies of 11.8%. In this work, an evaluation is presented of the parameters influencing this efficiency. More specially, the double exponential model is described as a primary efficiency limitation. Other parameters in processing the front contact are demonstrated to be well controlled for obtaining maximum efficiency. Finally, the process yield is defined, and the influence on it of all the parameters mentioned is described.

11488 Optical, structural, and compositional characterization of TiO/sub x/ antireflection coatings. Armigliato, A.; Celotti, G.; Guerri, S.; Martinelli, G.; Ostoja, P.; Rosa, R. (Univ. of Ferrara, Italy). pp 784-791 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A set of TiO/sub x/ antireflection coatings (x ≃ 2) have been prepared by vacuum evaporation of TiO in oxidizing environment

and characterized by several different techniques in order to obtain films with the best-matching refractive index on silicon and the lowest optical absorption throughout the whole visible and near-infrared range. Optical parameters were determined by ellipsometric method, through the elaboration by a proper computer programme allowing also for non-zero absorption; in addition the reflectivity was directly measured. The structure of deposited films was analyzed by transmission electron microscopy and electron diffraction. Stoichiometry of the films was determined by means of electron microprobe analysis and Rutherford nuclear backscattering techniques. The effects of the evaporation parameters were tested, and the substrate temperature was shown to exert the main influence on the optical characteristics, whereas only minor and irregular dependence from the oxygen partial pressure and the deposition rate was detected. A fairly logarithmic variation of the refractive index with the average crystallite size of the various titanium oxides identified was found; also the absorption index results greater for those samples which present a higher degree of crystallinity.

11489 Computer model for polycrystalline Si n^+/p solar cells. Makram-Ebeid, S. (Laboratories d'Electronique et de Physique Appliquee, Limeil, France). pp 792-799 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A computer model has been built to calculate the spectral response and photocurrent in an n^+/p photovoltaic cell made on RAD polysilicon. The major part of photocarrier recombination is assumed to occur on planar faults as suggested by recent EBIC experiments. Satisfactory predictions are obtained for the spectral response and AM1 photocurrent at different temperatures. The non-linear behavior as observed when the light flux is varied at different temperatures is also reasonably reproduced.

11490 High efficiency silicon solar cell for concentrator systems. Conti, M.; Modelli, A.; Vento, G. (SGS/ATES Componenti Elettronici Sip.A., Milan, Italy). pp 800-807 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The design, fabrication, and evaluation of a 2 in. high efficiency silicon solar cell suitable for concentrator systems is described. The cell is obtained diffusing a 0.3 μ thick N^+ region on the front of a 2 in. P type silicon wafer and alloying aluminium on the back. An antireflecting coating of plasma-deposited Si_3N_4 is deposited on the front. Front metallization consists of a comb shaped metal grid done on Ti, Pd, and Ag with octagonal symmetry. Grid spacing is .6 mm and the radial fins end on an annular ring of 44 mm inner diameter. The cell is reliably soldered on a steel frame covered with nickel and a tin-lead alloy which provides good electric contact and efficient heat sink. Efficiency performances of this cell as a function of concentration ratio and temperature are presented. Values in excess of 17% AM1 at 28°, 50 suns are routinely obtained with FF in excess of 74%. Preliminary results of reliability tests on this cell are also reported.

11491 High efficiency transcells and vertical multijunction cells for double-sided concentrated illumination. Cuevas, A.; Sangrador, J.; Luque, A.; Ruiz, J.M.; Sala, G. (Polytechnic Univ., Madrid, Spain). pp 808-816 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The use of two different structures as double side illuminated solar cells is considered: a n^+pn^+ structure (Transcell) and a vertical multijunction edge-illuminated cell. Efficiencies between 13% and 15.5% have been measured for the Transcell under illumination levels ranging from 0.5 to 15 equivalent AM1 suns; the related efficiency for the V.M.J. cell varies from 8.5% to 11.5%. The spectral external quantum efficiency measured for the transcell is greater than that of a conventional cell in the ir region due to its rear collection effect. The V.M.J. cell has a spectral response relatively higher than that of the conventional cell both in the ir and the uv regions, although it is lower in absolute value.

11492 Advances in theory, fabrication, and applications of bifacial solar cells. Chevalier, Y.; Duenas, F. (CIEA-IPN, Mexico City, Mexico). pp 817-823 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A theoretical analysis of efficiency and absolute spectral response of bifacial solar cells under back and front illumination is presented. It is shown that, for back illumination, the cell response is strongly dependent on the back surface recombination velocity. Experimental and theoretical absolute spectral response curves show an excellent agreement. Measurements show that a reduction in back surface recombination velocity is obtained by means of SnO/sub x/ chemical spray deposition. However, further investigation is needed in order to reduce the back surface recombination velocity to values allowing a back response of the bifacial cell similar to its front response. Finally, possible applications of bifacial cells are presented.

11493 Integrated Cu_2S-CdS thin film solar cell generator. Arndt, W.; Bilger, G.; Hewig, G.H.; Pfisterer, F.; Schock, H.W.; Woerner, J.; Bloss, W.H. (Univ., Stuttgart, Germany). pp 826-834 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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Large area Cu_2S-CdS thin film solar cells can be produced with an efficiency of over 7%. The thin film technology, which is used for the fabrication of the solar cells, enables it to produce integrated thin film solar cell generators with higher output voltages. Back contacts and n-type CdS-layers are evaporated. The p-type Cu_2S-layer is produced by dipping (Clevite-process). The transparent front contact is fabricated on the front glass using silk screening and etching techniques. The front contact connects the different solar cells in series. Thin film solar cell generators are produced consisting of eight 7 x 7 cm^2 large area solar cells. If one substrate glass and one front glass, each with an area of 14.5 x 28 cm^2, are used generator efficiencies up to 2.4% are achieved. Using one front glass with the connecting grids and 8 discrete 7 x 7 cm^2 substrate glasses with pn-junctions, which show a similar IU characteristics, generator efficiencies up to 4.3% are achieved.

11494 Preliminary test case manufacturing sequence for 50 cent/watt solar photovoltaic modules in 1986. Bickler, D.B. (Jet Propulsion Lab., Pasadena, CA). pp 835-842 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The Production Processes and Equipment Area of the Jet Propulsion Laboratory's Low-Cost Solar Array Project has prepared a test case manufacturing process sequence. It is offered as an idealized way of manufacturing solar modules for sale at a price of 50 cent/watt (1975 US dollars). The process is outlined, cost details are presented, and a factory floor plan with machine layout is given. A comparison is made to current costs for these same processes, and a state-of-the-art manufacturing sequence is shown with costing details for comparison purposes.

11495 Photovoltaics commercialization readiness assessment. Morse, F.H. (Dept. of Energy, Washington, DC). pp 843-850 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

During the spring and summer of 1978, a Department of Energy Task Force was formed to assess the commercial readiness of photovoltaic systems and, based on an evaluation of the barriers and potential actions, to develop a commercialization strategy to enhance the probability of reaching the goals of the National Photovoltaic Program Plan. After addressing the technical, market/economic, environmental and institutional readiness of photovoltaic systems, conclusions are presented and discussed.

11496 Comparison of optical and electrical properties of hydrogenated a-Si films formed by glow discharge of SiH_4 or $SiCl_4/H_2$. Plaettner, R.D.; Kroehler, W.W.; Rauscher, B.; Stetter, W.; Grabmaier, J.G. (Siemens AG, Muenchen, Germany). pp 860-866 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The deposition and properties of two types of a-Si films realized using an rf glow discharge of 100% silane (SiH_4) and of $SiCl_4/H_2$ are reported; newly introduced a-Si films formed from $SiCl_4/H_2$ may be practical for solar cell applications. The respective concentrations of hydrogen (up to 15%) and chlorine (up to 2%) in the films were determined by ir spectroscopy, mass spectrometry, x-ray fluorescence analysis and ion chromatography, and found to be dependent on the glow discharge process parameters such as deposition temperature, gas pressure, gas flow and rf power. Film thicknesses up to 10 μm were realized. The refractive index and absorption constant of the films at wavelengths between 0.5 μm and 2.5 μm, their electrical conductivity over the temperature range of 300 K < T < 670 K, and the spectral dependence of their photoconductivity at room temperature were determined. The photoluminescence of the films was determined and found to be dependent on the values of the process parameters and surface roughness.

11497 Model for the photovoltaic effect in Cu_2S-CdS solar cells in the backwall configuration. Bordure, G.; Henry, M.O.; Jacquemin, J.L.; Savelli, M. (Univ. of Science and Techniques, Montpellier, France). pp 868-873 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A modeling of Cu_2S-CdS solar cell in backwall configuration is proposed in order to estimate the effect of a spike in the energy band diagram at the interface on the collection of current carriers and to determine the respective contribution of Cu_2S and CdS in the conversion on the point of view of light absorption and current carriers creation. The dependence of photovoltaic factors under AM1 illumination on the value of the spike ΔE/sub c/ at the interface shows that, for a value over 100 MeV, the efficiency of the cell decreases rapidly. Thus we can say that there is either no discontinuity or its height does not exceed 0.1 eV. The efficiency of the cell under AM1 illumination is very sensitive to the values of absorption coefficients of Cu_2S and CdS respectively. Different experimental absorption coefficients have been used in the model. The conclusion is that the contribution of photogenerated holes in CdS to photovoltaic conversion is small and in any case does not compensate transmission losses through CdS. For a CdS layer thickness of 4 μm, efficiency varies from 2% to 11%. Efficiency reaches 18% when no absorption occurs in CdS. These results lead to the conclusion that CdS acts as a collecting electrode. Furthermore, comparison is made for the short circuit current in backwall and frontwall configurations.

11498 Thin film CdS/Cu_2S solar cells prepared by electrophoresis. Williams, E.W. (EMI Ltd., Hayes, England); Jones, K.; Griffiths, A.J.; Roughley, D.J.; Bell, J.M.; Steven, J.H.; Huson, M.J.; Rhodes, M.; Costich, T. pp 874-881 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The aim of the work was to carry out research on cheap large area solar cell films on metal and plastic substrates. CdS colloids were first prepared by reaction of hydrogen sulfide and cadmium salts. Electrophoretic deposition from these colloids was carried out using metal, conducting semiconductor oxide or ion plated plastic anode. After annealing the thin 1 to 2 micron films at low temperatures, a copper sulfide coating was applied to complete the heterojunction. Screen printed mesh top contacts were applied and the full solar cell characteristics were measured. Large area films of CdS were produced and a 125 cm length of steel foil was coated continuously. Solar cell efficiencies were in the range 1 to 5%. The series resistance was high and the film resistivity never fell below 10^3 ohm cm. Scanning electron microscope studies showed that aligned grains were produced by the annealing of the CdS films. It is possible that the efficiencies of the cells may be improved by lowering the series resistance of the films and further work is needed on doping and annealing of the films. Cheap large area solar cells can be produced and this may well be the first time that such a large area of CdS solar cell film has been deposited by a continuous process. Production of cells on plastic substrates gives hope for thin film flexible solar cells for a wide range of applications in the future.

11499 Photon loss analysis and design of thin-film planar junction Cu_2S/CdS devices. Bragagnolo, J.A. (Univ. of Delaware, Newark). pp 882-889 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Planar junction devices with increased open-circuit voltage and projected efficiency over 10% have been obtained by solid-state reaction growth of Cu_2S on unetched CdS layers. When the morphology of the Cu_2S layer is changed, a substantial decrease in short-circuit current (J/sub sc/) is observed. A quantitative photon loss analysis shows that achievable J/sub sc/ in present planar cells is limited by reflection and that re-emission of light after internal reflection in the cell is the primary contributor to the measured losses. Light trapping, caused by diffuse internal reflection leading to total internal reflection of outgoing photons at the outer cell boundary, reduces re-emission losses of thin-film polycrystalline CdS/Cu_2S devices to a fraction of their value for a plane-parallel multilayer device. Variations in cell morphology, leading to changes in diffuse internal reflection, can explain the observed differences in reflection losses. This analysis can be useful in developing designs and processing technique for increased photon collection efficiency of thin-film cells.

11500 Magnetron reactive sputtering deposition of Cu_2S/CdS solar cells. Anderson, W.W. (Lockheed Palo Alto Research Lab., CA); Jonath, A.D.; Thornton, J.A. pp 890-897 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A multicathode deposition system has been developed and used to deposit multilayer films of Cu_2S/CdS/Nb in a single pump-down. In addition, it has been used to prepare In-doped CdS films by co-sputtering of Cd and In in an Ar-H_2S atmosphere. The systematics of reactively sputtering CdS films were determined, especially the effects of substrate temperature and chamber wall chemistry. Resistivity of CdS and Cd/sub 1-x/Zn/sub x/S films could be controlled by In doping. CdS resistivities from 10^3 Ω-cm to 10^{-2} Ω-cm and Cd/sub .9/Zn/sub .1/S resistivities from 10^4 Ω-cm to 10 Ω-cm were obtained. Copper sulfide coatings 0.15-μm thick were deposited by reactive sputtering from an OFHC Cu target in an Ar-H_2S atmosphere. At high substrate temperatures and low H_2S injection rates, a high resistivity Cu/sub x/S phase was normally obtained. Optical absorption, resistivity-versus-temperature, and x-ray diffraction measurements indicate that the high resistivity material consists largely of near stoichiometric, chalcocite, possibly stabilized by excess copper. All vacuum deposition process Cu_2S/CdS photovoltaic junctions have been fabricated by sequentially sputtering Cd and then Cu in an H_2S and Ar gas mixture. Ohmic contact to the CdS layer has been established by use of a Nb coated substrate. Photovoltaic response of as-deposited junctions (i.e., without subsequent heat treatment) is obtained with appropriate deposition parameters.

11501 Chemistry of cadmium sulfide formation from cadmium chloride and thiourea. Dutault, F.; Lahaye, J. (Centre National de la Recherche Scientifique, Mulhouse, France). pp 898-902 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The phenomena occurring and the compounds formed during the spray of an aqueous solution of cadmium chloride and thiourea are studied. At first the water evaporates and a complex crystallizes. The empirical formula $CdCl_2[SCN_2H_4]$ and the structure (double octahedron chains) of this complex not quoted in the literature were determined. This complex decomposes thermally to cadmium sulfide. However a chloride content remains in the films depending on the highest temperature of deposition or annealing.

11502 Optical and calorimetric measurements of cupreous sulphides thin films. Arjona, F.; Elizalde, E.; Feu, A; Garcia Camarero, E.; Leon, M.; Llabres, J.; Rueda, F. (Univ. Autonoma, Madrid, Spain). pp 903-9098 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Polycrystalline thin films of cupreous sulfide have been obtained by sulfuration of copper and by vacuum evaporation. In the method the rate of chalcocite formation has been monitored by electrical conductance measurements; optical transmittance, and reflectance give values of the direct and indirect transition gaps, 2.0 eV and 1.16 eV as the pure chalcocite films, when sulfuration is completed. Differential calorimetric measurements performed in pure chalcocite films indicate that the transformation begins at 88.0 +- 1°C, presenting a single peak. The heat of transformation is ΔH = 544 +- 10 cal/mol the energy of activation E = 0.17 eV and the frequency factor A = 166/sec. When comparing with a 90% djurleite sample a shift in the temperatures of transition appears, showing that the calorimetric measurements are adequate for chalcocite and djurleite content determination in thin films.

11503 CdS heterojunction and Schottky barrier photovoltaic devices. Robertson, M.J.; Woods, J. (Univ. of Durham, England). pp 909-916 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

CdS-Cu/sub x/S heterojunction and CdS Schottky barrier cells prepared on undoped and copper-doped single crystal substrates have been investigated. Reflection electron diffraction has been used to determine the phase of the Cu/sub x/S, and methods have been developed to prepare layers of pure chalcocite and pure djurleite. Measurements have been made of the spectral distribution of the SCC, OCV, and the photocapacitance. This has been done with and without a constant bias illumination flooding the CdS. The results show unambiguously that the short 200°C bake normally administered to heterojunction cells following the formation of the Cu/sub x/S layer does produce a photoconductive i-layer in the CdS. In most cells illuminated with bias light there is a peak in the SCC when the device is irradiated with light absorbed at the band gap of the CdS. In contrast the OCV displays a minimum under these conditions. This and all the other effects described can be

explained in terms of a potential energy model which allows (1) the formation of a photoconductive layer of CdS after the 200°C bake, and (2) the absorption of oxygen at the junction interface during the bake, so that a small spike is formed at the junction of the conduction bands of the Cu/sub x/S and the CdS.

11504 Preparation and analysis of Cu_2O thin-film solar cells. Herion, J.; Natsch, B.; Niekisch, E.A.; Scharl, G. (Kernforschangsanlage, Juelich, Germany). pp 917-924 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Cu_2O thin-film front wall solar cells were fabricated using partial thermal oxidation of Cu foil. By means of an inexpensive technique, efficiencies of 0.4% (without AR coating), open circuit voltages of 0.5 V, and fill factors of 0.45 were obtained. The grain structure of the Cu_2O layers is columnar and grain diameters larger than the thickness of the layers were achieved. When compared with more developed types of Cu_2O cells the short circuit current is still low corresponding to a low spectral response in the blue part of the spectrum. The relatively small fill factor is mainly due to the high series resistance of the cells. However, no limitation of the short circuit current is observed because the series resistance decreases with increasing illumination level. Different slopes of the V/sub oc/-log I/sub sc/ dependence are found at low and high illumination levels, respectively. Auger and XPS measurements indicate that the type of cell is rather a heterojunction than a MS structure.

11505 Accurate computer analysis of solar cells including band-gap variation application to the Al/sub x/Ga/sub 1-x/As GaAs structure. Therez, F.; Martinot, H.; Esteve, D. (Laboratoire d'Automatique et d'Analys des Systemes, Toulouse, France). pp 926-937 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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To calculate exactly the device characteristics we have extended an existing homojunction computer program to variable composition structure solar cells. All the physical mechanisms which are excluded from approximate calculations can be included in the numerical scheme. The numerical results have given particular information on solar cell operation mechanisms. The current crossing the device cannot be considered as the superposition of the dark and illuminated currents over the whole I(V) charactristic. The validity of the superposition principle is checked with the accurate dark and illuminated I(V) curves. The superposition principle is not satisfied at low current densities. It is valid at one sun generated short circuit current density for III.V. compound solar cells. The results of the solar cell output factors, such as short-circuit current density, efficiency versus carrier lifetimes and junction depth are computed.

11506 Efficient GaAs shallow-homojunction solar cells on single-crystal GaAs and Ge substrates. Fan, J.C.C.; Bozler, C.O. (Massachusetts Inst. of Tech., Lexington). pp 938-945 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Three types of efficient GaAs shallow-homojunction solar cells have been fabricated without the use of Ga/sub 1-x/Al/sub x/As window layers. These devices employ an $n^+/p/p^+$ structure in which surface recombination losses are reduced because the n^+ layer is so thin - less than 0.1 μm - that most of the photogenerated carriers are created in the p layer below the junction. The cells are fabricated by a simple technique that utilizes an antireflection coating prepared by anodization of the n^+ layer. The contacts are electroplated gold or tin. Conversion efficiencies exceeding 20% at AM1 have been obtained for 1 cm x 0.5 cm cells of two types, which incorporate p and n^+ layers grown by chemical vapor deposition (CVD) on single-crystal p^+ substrates. One of these types uses GaAs substrates, the other Ge substrates. In cells of the third type, the n^+ layer is formed by implantation of Se^+ ions into a CVD-grown p GaAs layer, followed by laser annealing. Conversion efficiencies up to 12% at AM1 have been obtained for small cells of this type, although these ion-implanted, laser-annealed (IILA) cells are still in an early stage of development.

11507 Influence of an interfacial oxide layer on Au/n-GaAs Schottky barrier solar cells. Van Meirhaeghe, R.L.; Verspurten, E.S.; Cardon, F.; Gomes, W.P. (Rijksuniversiteit, Gent, Belgium). pp 946-951 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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In Schottky barrier solar cells, an oxide layer is often present on the semiconductor. The purpose of our work was to study the influence of the thickness of this layer on the solar cell characteristics of Au/n-GaAs single crystal systems. Several etching procedures were investigated in order to obtain an as thin as possible oxide layer. The thickness of this layer was determined ellipsometrically. A H_2SO_4:H_2O_2:H_2O mixture (3:1:1) was found to yield th best results. An oxide layer thickness of 15 A was obtained in this way. Cells made on such substrates were taken as base-cells. The next step consisted in the growth of thicker oxide layers by several methods, e.g., in air at room temperature or by thermal oxidation. The dependence of film thickness on time was measured ellipsometrically and a logarithmic law was found. Several characteristics have been studied as a function of oxide layer thickness. Current-voltage measurements in darkness revealed its influence on the reverse as well as on the forward current. Also the effect upon the diode ideality factor and upon the relationship between open-circuit voltage and light intensity were investigated. Capacitance versus voltage measurements were undertaken in order to study the variation of the height of the built-in-barrier. The values of the open-circuit voltage and of the short-circuit current, the efficiency and the spectral response were also studied. Measurements were made on the Ga-rich (111) as well as on the As-rich (111) surface. It can be concluded that the etching procedure is very critical in realizing Schottky barrier solar cells, as it influences strongly the interfacial layer thickness. Starting from a minimum oxide layer, thicker layers can be grown and an optimum value for solar cell behavior can be derived.

11508 A new process using organometallics for the elaboration of thin layers of III-V materials by chemical vapor deposition at low temperature. Zaouk, A.; Salvetat, E.; Montel, G.; Lebugle, A.; Constant, G. (Ecole Nationale Superieure de Chimie, Toulouse, France). pp 952-959 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979). (In French)

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Polycrystal and single crystal layers of III-V semi-conductor compounds have been obtained by chemical vapor deposition, using complexes characterized by a donor acceptor bond between the III and V elements. We have chosen complexes having the general formula: $Cl(C_2H_5)_2M$/sub III/.M/sub V/$(C_2H_5)_3$. Such liquid complexes have been used successfully in the preparation of III-V materials films: so GaAs, GaN, AlP, AlN polycrystal layers have been obtained between 400°C and 700°C on various substrates; and GaAs epitaxial layers have been deposited on (111) Ge and (100) GaAs substrates.

11509 AlSb as a candidate material for photovoltaic solar energy conversion. Leroux, M.; Tromson-Carli, A.; Gibart, P.; Verie, C. (CNRS, Meudon, France). pp 968-975 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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The main properties of AlSb are examined in the context of large scale efficient photovoltaic solar energy conversion. The role of ionicity, the problem of photovoltaic materials availability, the importance of the band structure, and the achievement of large epitaxial wafers are studied. This last salient feature is emphasized through a description of the AlSb epitaxy achieved for the first time using a metalorganic-chemical vapor deposition method. An efficiency of 12% at AM1 is predicted.

11510 Testing flat place photovoltaic modules for terrestrial environments. Hoffman, A.R.; Arnett, J.C.; Ross, R.G. Jr. (California Inst. of Tech., Pasadena). pp 978-986 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The development of test requirements, equipment, and procedures for flat plate photovoltaic modules has been one part of the Jet Propulsion Laboratory's Low-Cost Solar Array Project. A primary objective of the project, which is being performed for the United States Department of Energy, is the timely development of low-cost, commercial-quality photovoltaic arrays through an active program of industrial and academic involvement. Development of test technology for modules is an important and necessary step toward meeting this objective. Various electrical performance and environmental testing requirements are discussed in terms of their significance as well as the rationale for the specified levels and durations. Comparisons between field-observed degradation and test-induced degradation are showing a positive correlation with some of the observed field effects. The status of research efforts for the development of test methodology for field-related problems is reviewed.

11511 Physical/chemical modeling for photovoltaic module life prediction. Moacanin, J.; Carroll, W.F.; Gupta, A. (California Inst. of Tech., Pasadena). pp 995-1001 of 2nd E.C. photovoltaic solar energy

conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A generalized methodology has been developed and is being used to identify and evaluate potential degradation and failure of the functions of terrestrial photovoltaic encapsulation. Failure progression modeling and an interaction matrix are used to complement the conventional experimental and intuitive approach to failure/degradation mode identification. The mechanisms and rates of change are initially modeled as explicitly as possible; models are improved as new analytical and experimental data are generated. Comparison of the predicted performance based on these models can result in: (1) constraints on system or component design, materials, or operating conditions; (2) qualification (predicted satisfactory function); or (3) uncertainty. An uncertain answer leads to definition of required additional analytical or experimental investigations. These can be prioritized at each stage of the program by examining the sensitivity of the mechanistic definitions and rate equations. The required accuracy of experimental results can be defined or estimated by sensitivity analysis of governing equations. The approach has been applied to the study and correction of an unexpected delamination failure. It is currently being used to evaluate thermo-mechanical interactions in photovoltaic modules and to study corrosion of contacts and interconnects.

11512 Hybrid silicone-glass Fresnel Lens as concentrator for photovoltaic applications. Sala, G.; Lorenzo, E. (Polytechnic Univ., Madrid, Spain). pp 1004-1010 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Acrylic Fresnel lenses are widely accepted in the photovoltaic specialist community as a good concentrator approach. We have developed a hybrid Fresnel Lens made of glass and transparent silicone. Both materials are of high resistance to outdoor conditions. The objective is to design and manufacture 144 square hybrid Fresnel lenses of 40 x 40 cm^2 to act as concentrators in the 2 KW Ramon Areces Photovoltaic Array. The dispersive characteristics of the silicone resin used, Sylgard 182 of Dow Corning, has been measured. A lens providing a quasi-uniform current density generation on the receiver has been designed. The lens has 350 circular grooves but only 35 different tilt-groove angles. Variation of optical and adherence properties of the lens are not significant after thermal and chemical aging cycles. The estimated cost of the hybrid lenses is $30/$m^2$ which is competitive. The manufacturing process is very simple and needs a very small equipment investment.

11513 Cassegrain solar concentrators for photovoltaics. Cobble, M.H.; Lumsdaine, E.; Hull, W.C.; Wabrek, R.M. (New Mexico State Univ., Las Cruces). pp 1011-1020 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A solar concentrator consisting of a paraboloid of revolution that tracks the sun, and an hyperboloid of revolution reflector that has a focus in common with the paraboloid is analyzed using a three-dimensional ray trace to determine the image shape and the concentration to be obtained for various eccentricities of the hyperboloid when used with a 152.4 cm diameter paraboloid (f = 64.88 cm). The concentration for a non-uniform sun, a uniform sun and the concentration with mirror imaging errors is determined as a function of image radius. Silicon photovoltaic cells for use in this concentrator are tested at low concentration, and some preliminary current-voltage results are given.

11514 Hybrid system consisting of silicon solar cells with concentrators and heat pump. Stojanovic, M.S.; Milinkovic, L.S. (Boris Kidric Inst. of Nuclear Sciences, Belgrade, Yugoslavia). pp 1021-1026 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

In addition to heat energy of low quality (temperature is about 50°C) which is obtained by cooling the solar cells, heat energy can be added by the heat pump driven by the electric power generated in the same solar cells. The importance of the considered hybrid system lies in the fact that it is autonomous and can be used as a refrigerator. Analysis of the suggested system based on technical characteristics of available commercial units (silicon solar cells, Fresnel's concentrators and heat pump) shows that we are approaching the economical use of solar cells for the production of electric energy and that its conversion to heat energy via heat pump is justified.

11515 Status of the US Photovoltaic R and D Program. Feucht, D.L.; Burke, J.R. (Solar Energy Research Inst., Golden, CO). pp 1106-1112 of 2nd E.C. photovoltic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The goals of the Photovoltaic AR and D Program are (1) to develop thin film semiconductor and novel photovoltaic conversion concepts; (2) to demonstrate the feasibility of producing these cells for a price of $100 to $300 per peak kW electric output (in 1975 $) by FY 1986. The FY 79 budget for this program is approximately $33M. The research program is reviewed. (WKH)

11516 US Department of Energy National Photovoltaic Program plan. Magid, L.M. (Dept. of Energy, Washington, DC). pp 1113-1119 of 2nd E.C. photovoltic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The US Department of Energy (DOE) is currently restructuring the Photovoltaic Program within the Division of Distributed Solar Technology. The program's objective is to bring photovoltaic systems, via substantial research, development, and demonstrations aimed at achieving major cost reductions and market penetration, to the point where they are able to supply a significant portion of the United States' energy requirements. A key element in this program is the belief that photovoltaic residences will begin to be cost-effective within the Southwestern United States when arrays are priced at 70 cents/peak watt and the total installed systems will cost from $1.60 to $2.20/peak watt (in 1980 dollars). The program now being planned anticipates this occurring in 1986.

11517 Photovoltaic research and development projects in the Federal Republic of Germany. Koepke, R. (Kernforschungsanlage, Juelich, Germany). pp 1120-1127 of 2nd E.C. photovoltic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The status of the solar cell development for terrestrial applications in West Germany is reviewed. Most of the projects are part of the Solar Energy Technologies Program, 1977-1980, funded by the German Government. Research on monocrystal, polycrystal, and amorphous silicon solar cells, Cu/sub x/S/CdS solar cells, and other materials for solar cells is outlined. (WHK)

11518 Italian activities in photovoltaics. Pizzini, S. (Istituto Donegani, Novara, Italy); Califano, F.; Soncini, G. pp 1128-1134 of 2nd E.C. photovoltic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Progress in R and D activities, in demonstration and in industrial development of photovoltaic modules and arrays is described. Details on the structure of the CNR photovoltaic program are given as well as latest achievements both in research and development.

11519 French program on photovoltaic conversion. Rodot, M. (Centre National de la Recherche Scientifique, Paris, France). pp 1135-1140 of 2nd E.C. photovoltic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A description of the photovoltaic R and D activity in France, 1976-1979, is given. Topics include budget, main laboratories involved, and distribution of research topics.

11520 Canadian photovoltaic R and D activities. Simpson, J.H. (National Research Council, Ottawa, Canada). pp 1141-1148 of 2nd E.C. photovoltic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Photovoltaic research is supported by the Canadian Government in two ways: (1) through the National Sciences and Engineering Research Council (NSERC) which makes grants to university groups doing long term research. In the photovoltaic field NSERC at present supports four projects of 3 years duration; (2) through the National Research Council, Solar Energy Project (SEP) which contracts out shorter term industrial research and development projects to companies. University groups may be subcontractors to companies under this program. An in-house project in the NRC Division of Chemistry is also supported. It is hoped that successful projects under Program (1) will be sponsored by a company and supported under Program (2). The subject matter of these projects

and associated investigations including a market survey of Canada's requirements are reviewed. A brief outline of expected trends over the next 5 years is given.

11521 European Photovoltaic R and D Programme. Treble, F.C.; Grassi, G.; Mertens, R. pp 1149-1152 of 2nd E.C. photovoltic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The R and D Program of the Commission of the European Communities in photovoltaic solar energy conversion is aimed at reducing the cost of photovoltaic power generation by using cheaper materials, raising conversion efficiencies, cutting manufacturing costs, and improving long-term reliability, in order to encourage a progressive expansion of the present small market. A sum of 5.35M units of account is being spent over the four-year period ending June 1979. The program, which has been organized in two phases, covers the areas of silicon cells and modules, alternative types of cells, concentration, system studies, and demonstration projects. Details of the program, with a list of projects, are presented and the achievements to date assessed. A new four-year program, with much higher funding and more emphasis on systems and demonstrations, has been proposed and is at present under consideration.

11522 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979). 1228p. (In English and French). (EUR—6376; CONF-790457—).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Separate abstracts were prepared for 121 of the 129 papers presented. Eight papers were previously included in the data base. Introductory speeches are also presented. (WHK)

11523 Influence of grain size and dopant concentration on the electrical properties of polycrystalline silicon films. Graef, M.W.M.; Bloem, J.; Giling, L.J.; Monkowski, J.R.; Maes, J.W.C. (Catholic Univ., Nijmegen, Netherlands). pp 65-74 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Polycrystalline silicon layers with different mean crystallite size were grown onto various substrates via chemical vapor deposition. The conductivity and carrier concentration of these films was studied as a function of the doping concentration. The conclusion, drawn from these studies, is that in polycrystalline silicon the dopant is distributed homogeneously throughout the film. No apparant dopant segregation was found for phosphorus and boron concentrations between 10^{15} and 10^{19} atoms/cm^3. Thus, the electrical behavior is solely determined by electrical energy barriers at the grain boundaries. Measurements of the mobility and the temperature dependence of the conductivity lead to a quantitative model for the energy band structure at grain boundries, viz. a homogeneous continuous distribution of interface states over the band gap.

11524 Comprehensive explanation of efficiency limits in silicon solar cells. Redfield, D. (RCA Laboratories, Princeton, NJ). pp 75-81 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The large discrepancy between the best observed AMO efficiency (15%) of silicon solar cells and predicted theoretical values (20 to 22%) is explained in a single comprehensive model based on Auger processes in heavily doped silicon. This single class of physical processes accounts for all four major types of limitations observed: the contributions of both the front and base regions to both the open-circuit voltage V/sub oc/ and the short-circuit current density J/sub sc/. This explanation replaces various fragmented previous models and shows that observed limitations are inherent in the design of these cells, and are not consequences of technological faults.

11525 Technology and economics of starting materials for low-cost silicon solar cells. Sirtl, E. pp 84-97 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Different ways have been developed or re-explored to manufacture high-purity silicon at low costs. The target of these worldwide efforts is to provide a bulk material being characterized by the following aspects: (1) abundance of resources; (2) low-cost manufacturing; (3) impurity optimization (solar grade); and (4) low-energy processing. Excluding film deposition techniques, a survey of presently investigated processes is given. The different approaches are chemically characterized and compared through the items indicated above.

11526 Progress on the Dow Corning process for solar-grade silicon. Hunt, L.P.; Dosaj, V.D. (Dow Corning Corp., Hemlock, MI). pp 98-105 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The Dow Corning process consists of the carbothermic reduction of silica to produce silicon which is subsequently purified by segregation of impurities during unidirectional solidification. Use of high-purity raw materials has increased the purity of silicon from the carbothermic reduction step to 99.99%. Quartz deposits have been identified as adequate sources of silica with respect to purity and quantity of supply. The best carbon reductant consists of carbon black powder formed into pellets using sucrose as a binder. Silicon was produced from these raw materials at about 3 kg/h during 60-h periods. The silicon analyzed to have Al and Fe concentrations less than 100 ppmw with levels of all other impurities less than 10 ppmw each. Silicon was purified by pulling a polycrystalline ingot from the melt. The purest silicon had 7 ppma boron (0.12 ohm-cm), <0.7 ppma phosphorus, and metal impurities equivalent to semiconductor silicon. The best solar cell fabricated on single-crystalline silicon pulled from the polycrystalline ingot had a 13.4% AMO efficiency (AR-coated). A cost analysis of the overall process indicated that it has good probability of meeting the $10/kg goal of the US Department of Energy.

11527 Low-cost, high-efficiency silicon by heat exchanger method and fixed abrasive slicing technique. Khattak, C.P.; Schmid, F. (Crystals Systems, Inc., Salem, MA). pp 106-113 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The Heat Exchanger Method (HEM) has been adapted for growth of silicon crystals. Ingot cracking was the major problem. It has been overcome with the development of a silica crucible with a graded structure. Conditions for vacuum processing have been established This has eliminated the use of the expensive high-purity argon. Solar cells fabricated from HEM silicon have shown conversion efficiencies of up to 15% (AM1). It has been demonstrated HEM produces silicon at low costs without compromising the quality of the material. It is the only technique which yields square cross-section, single-crystal silicon. This allows high solar-cell packing efficiency in arrays and thereby further cost reductions. A modified multi-blade slurry machine has been used to establish the concept of multi-wire Fixed Abrasive Slicing Technique (FAST). In this approach diamond is fixed on wires and reciprocated to slice silicon. Twenty-five wafers per linear cm giving a conversion ratio of 1.08 square meters of wafer per kilogram of ingot has been demonstrated. These wafers do not exhibit edge chipping and have a surface damage of 3 to 5 μm. A high-speed slicer has been designed and fabricated for multi-wire FAST slicing. Workpieces of up to 10 cm diameter have been sliced. Projected economic analysis of HEM casting and FAST slicing show an add-on cost of $10.62 per square meter of wafer.

11528 Early assessment of the photovoltaic potentialities of RAD polysilicon sheets. Belouet, C.; Fabre, E.; Makram-Ebeid, S.; Phuoc, N.T.; Texier, C. (Laboratories d'Electronique et de Physique Appliqué, Limeil, France). pp 114-122 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

It is shown that AM1 conversion efficiencies of about 11% can be reasonably envisaged for RAD polycrystalline solar cells. The factors limiting the performances of the cells - planar faults, carbonaceous precipitates and layer/substrate interface - are discussed and the directions for further improvements are briefly outlined.

11529 Wide silicon ribbon growth by capillary action shaping technique. Gessert, C.; Schwuttke, G.H. (IBM, East Fishkill Labs., Hopewell Junction, NY). pp 123-129 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Silicon ribbons up to 127 mm wide have been grown by the Capillary Action Shaping Technique (CAST) using graphite dies. Growth conditions for the wide ribbons are discussed, and some preliminary results of characterization of the wide ribbons are presented.

11530 Low cost crystalline silicon. Schwuttke, G.H. (IBM, East Fishkill Labs., Hopewell Junction, NY). pp 130-144 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Economically viable means of producing silicon sheets for low cost solar cells are discussed. Emphasis is given to the discussion of three major crystal growth techniques: (a) Czochralski, (b) ribbon, and (c) casting. Economic and technological comparison indicates that crystals grown in ingot shape (Czochralski) can meet a price goal of $2 per watt peak if semi-continuous crystal pulling can be implemented. Poly silicon at a price of $10.00 kg. is required. A lower price goal for ingot technology requires improvements in ingot slicing techniques. Ribbon technology has the potential of approaching a price goal of $1.00 per watt peak but it requires that sheets can be grown continuously directly from the melt at a width of 20 cm, 0.25 mm thick, and at a rate of 7 cm/min.

11531 Potential for improved silicon ribbon growth through thermal environment control. Gurtler, R.W.; Baghdadi, A.; Legge, R.N.; Ellis, R.J. (Morotola Inc., Phoenix, AZ). pp 145-152 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The Ribbon-to-Ribbon (RTR) process for growth of silicon ribbon is described. This process involves the fabrication of a microcrystalline ribbon of silicon and subsequent grain size enhancement through a laser recrystallization process. The microribbon is obtained from a Thermal Expansion Shear Separation (TESS) process which allows a CVD layer of silicon to be separated from a temporary molybdenum substrate. Efforts to achieve increased solar cell efficiencies and higher area production rates have been problematical. Furnaces, which are necessary for thermal stress control, have been shown to contribute contamination to substrates resulting in degraded efficiencies. Recent results with a new furnace design indicate efficiencies in excess of 9% will be routine. Limitations to area throughput arise due to fundamental linear velocity limitations and width limitations necessary to prevent the occurrence of thermal buckling. Calculations are reported which show the influence of thermal profile on buckling tendencies, and a proposed electron beam technique is considered which promises high throughput with minimal buckling.

11532 Ion implanted solar cells from EFG silicon ribbons. Bell, R.O. (Mobil Tyco Solar Energy Corp., Waltham, MA); Ho, C.T.; Ravi, K.V.; Wald, F.V.; Muller, J.C.; Siffert, P. pp 153-161 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

In an initial investigation of ion implantation into EFG silicon ribbon using both conventional and glow discharge techniques, solar cell efficiencies between 9.5 and 10.6% were achieved without efforts to optimize almost any of the variable parameters in the solar cell fabrication sequence. These techniques can thus be considered as being quite useful for terrestrial solar cell fabrication, particularly if high implantation rate equipment becomes available. At present, it may be shown that in a laboratory scale glow discharge apparatus, implant rates of ~ 2 cm/min can be achieved on 2.5 cm wide ribbon in a continuous fashion. However, the laser pulse annealing process used in conjunction with this technique needs to be optimized. This is being accomplished by installing a laser with a higher power output and automatic means to cover the total cell surface reliably with laser pulses.

11533 Experimental optimization of the efficiency of n^+pp^+ and p^+nn^+ silicon solar cells. Van Meerbergen, J.; Nijs, J.; D'Hoore, F.; Mertens, R.; Van Overstraeten, R. (Katholieke Univ., Leuven, Heverlee, Belgium). pp 164-171 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Two types of back surface field cells are discussed: p^+nn^+ and n^+pp^+. The efficiency is explained in terms of measured parameters such as impurity profiles, junction depths, the quality of surface, and the different sheet resistances. An efficiency of 14% has been obtained on non-polished grade II material with a process that can be automated.

11534 High volume process for silicon solar cells using solid diffusion sources. Thomas, R.E.; Salter, G.C.; Armstrong, A.A. (Carleton Univ., Ottawa, Ontario). pp 172-180 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A novel technique for preparing diffused junction n^+-p-p^+ or p^+-n-n^+ silicon solar cells using solid sources to simultaneously realize the junction and back surface field region is reported. The sources are in the form of thin (~ 90μm) solid discs composed of a mixture of boron or phosphorus in solid form, aluminum or silicon dioxide, and organic binders and coloring. By arranging the discs and silicon wafers alternately in close contact (n-disc/silicon/p-disc/silicon/n-disc...) in a stack, both p^+ and n^+ layers are formed during diffusion without the need for diffusion gases, masking or surface protection. This approach leads to cost savings by virtue of the reduced handling and chemical processing, the elimination of diffusion gases, and the potential for large batch sizes (up to 2500 cells/meter of furnace hot zone). Experimental n^+pp^+ solar cells realized using these sources have shown Am1 efficiencies up to 12% while p^+nn^+ cells have demonstrated efficiencies up to 13.8%. An automated process is proposed for large volume production of cells using either disc or ribbon substrates. This together with the promise of high cell efficiency and reduced costs makes the solid source diffusion technique worth serious consideration for large-scale production of solar cells.

11535 New diffusion process for silicon solar cells. Michel, J.; Martin, B.G. (Laboratoires d'Electronique et de Physique Appliquee, Limeil, France). pp 181-188 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A new diffusion process able to lead to a very low-cost and highly automated silicon solar cell fabrication has been investigated. It consists of doping with silicon dopants transparent and conductive layers of indium tin oxide deposited by spray onto the silicon, these layers being not removed after formation of the junction into the silicon by diffusion. Diffusion of phosphorous has not been achieved probably due to InP formation. Diffusion of boron leads to solar p^+/n cells having similar characteristics to those made with a classical diffusion.

11536 Effects of concentrated sunlight on silicon solar cells. Backus, C.E.; Rule, T.T.; Sanderson, R.W.; Chambers, B. (Arizona State Univ., Tempe). pp 189-196 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A large number of silicon concentration cells have been tested with efficiencies of 16 to 18% under illumination of 30 to 300 suns at a testing temperature of 28°C. Increasing temperatures linearly decreases the efficiency of these cells. Care must be taken in testing to ensure accurate values of incident intensity and cell temperature to properly interpret the results.

11537 Degradation effects in silicon Schottky barrier solar cells. Grimshaw, J.A.; Townsend, W.G. (Royal Military Coll. of Science, Shrivenham, England). pp 197-204 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Degradation of more than 20% in the efficiency of aluminium-thin oxide-silicon single and polycrystalline SBCSs has been induced by subjecting the cells to prolonged illumination at room temperature. Investigations of I/V curves have shown that both I/sub sc/ and V/sub oc/ slowly reduce to values depending on the illumination conditions. Recovery in efficiency can be brought about gradually by holding the cells in the dark, or by temperature cycling to 90°C for 15 minutes. Electrical parameters that have been affected are I_0, diode quality factor n, I/sub sc/, and in some cases r/sub s/. Degradation effects have been less on cells possessing a ZnS a.r. coating. Investigations of ion beam induced nuclear reactions on cell structures with no a.r. coating have shown the surface layers contain approximately double the quantity of oxygen anticipated on a simple model. An initial sputter/AES study indicates aluminium has migrated into the interface oxide and changed the chemical bondng in the layer, and that the metallic aluminium film itself is diluted throughout by aluminium oxide. It is suggested that the degradation is associated with atomic migrational processes stimulated by illumination, probably involving the migration of oxygen between the interface layer and the cell exterior via the metal.

11538 Advanced thin silicon solar cell with controlled optical absorptance. Rasch, K.D.; Roy, K.; Tentscher, K.H. (AEG-Telefunken, Heilbronn, Germany). pp 205-212 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

An advanced thin silicon solar cell with back surface reflector (BSR) is described. The BSR structure will be analyzed and design

limits of a BSR cell are identified. Emphasis is being placed on metallurgical problems of BSR, on the influence of surface processing and on the interface problem associated with matching the BSR structure to the existing standard contact system. Tests have been performed in order to determine the parameters controlling the solar absorptance α/sub s/. Finally a simple method to obtain α/sub s/ is proposed.

11539 Effect of laser irradiation on the characteristics of implanted layers for silicon solar cells. Zignani, F. (Univ. of Bologna, Italy); Galloni, R.; Pedulli, L.; Bentini, G.G.; Servidori, M.; Cembali, F.; Desalvo, A. pp 213-221 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A Q-switched ruby laser with 15 to 20 nsec pulse duration and about 20 mm spot diameter has been utilized in the energy density range between 1 and 2 J/cm^2 to obtain electrical activation of phosphorus implanted layers. Rutherford back-scattering and TEM analysis have been used to determine the structural characteristics, whereas electrical properties have been analyzed by resistivity and Hall effect measurement. Minority carriers life-times in the base material have been determined by the surface photovoltage technique both in CZ and FZ silicon samples as a function of laser energy density. Solar cells prototypes have been made by implanting 100 keV phosphorus ions followed by laser annealing and their I-V characteristics and spectral responses have been measured.

11540 Improved thick film semiconductor/solar cell contacts. Ross, B. (Bernd Ross Associates, San Diego, CA). pp 222-231 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The results to date on a study of all-metal thick film electrodes are reported. The requirements for an all-metal thick film electrode to semiconductors include a screenable, solid oxide scavenger, a low melting point metal powder furnishing a liquid phase sintering medium as a replacement for the glass frit, a vehicle with the proper rheological properties, and appropriate dopants to provide an ohmic, low-resistance metal-semiconductor interface. The silver system was chosen as the test vehicle for this concept. Three solid state oxide scavengers were identified. The most effective of these, silver fluoride, dissociates at firing temperatures into metallic silver and nascent fluorine gas. The gas etches the silicon dioxide which goes off as gaseous silicon tetrafluoride. The finely divided silver metal wets the silicon surface forming a tenaciously adhering layer. Differential thermal analysis and thermal gravimetric analysis show the reaction temperatures of silver fluoride and the acrylic binder. The effect of a low melting metal powder on the sintering action of the major constituent particles is illustrated by scanning electron microphotography. The barrier height of the undoped contact was approximated from C-V plots at 0.72 volts. Also reported are the results of an Auger electron analysis of the interface which was undertaken due to difficulties in obtaining ohmic contacts. The mechanical and metallurgical properties of the electrodes are excellent, but electrical parameters remain to be optimized.

11541 Recent advances in thin foil silicon solar cells. Iles, P.A.; Ho, F.F.; Soclof, S.I. (Photoelectronics Corp. of America, City of Industry, CA). pp 232-234 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; R. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Improvements in silicon solar cell technology due to the development of thin foil cells are discussed. The impact of thin foil silicon solar cells on improvements in space cells, theoretical goals, and concentrator cells is reviewed. (WHK)

11542 Progress in the field of terrestrial solar generators. Buhs, R.; Nagel, G.; Wegmann, H.D. (AEG-TELEFUNKEN, Wedel, Germany). pp 236-242 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; R. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The complete scope of the activities in the field of terrestrial solar generators at AEG-TELEFUNKEN is described. This covers the actual development activities, the automation of fabrication processes to reduce manufacturing cost, the prototype fabrication of solar generator modules, some current projects, and finally the development of alternatives to flat plate generators. Many of these activities are performed on the background of an eight-year-program mainly supported by the German Government.

11543 Study of sandwich type glass encapsulation. Salles, Y.; Anguet, J.; Desombre, A. (R.T.C. la Radiotechnique Compelec, Caen, France). pp 243-250 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; R. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The sandwich glass technology, widely used for safety windscreen appeared as a promising way to manufacture large terrestrial solar modules. The adaptation of such a process to the solar cell encapsulation has been carried out. At first, results of the feasability phase (30 x 30 cm panels) are given. It is then demonstrated that the above process is also suitable for larger modules (up to .5 m^2). The final design of the solar module is discussed in terms of assembling simplicity, industrial background, and weather resistance. Complete mechanic and climatic tests have been performed. It can be concluded that the module mechanical resistance is satisfactory and that the weather resistance of such an encapsulation is better, compared with the standard silicone one. Finally, a preliminary cost analysis shows that this process could be less labor consuming, for large scale production purpose, taking into account the long experience of car windscreen manufacturing.

11544 Optimization studies of materials in hydrogenated amorphous silicon solar cells. Hanak, J.J.; Korsun, V.; Pellicane, J.P (RCA Labs., Princeton, NJ). pp 270-277 of 2nd E.C. photovolatic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; R. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

In an effort to achieve higher efficiencies in solar cells made of hydrogenated amorphous silicon (a-Si:H), a preliminary optimization study of some of several possible materials parameters and deposition conditions for a multilayer p^+-i-n^+ cell structure was made. An automated approach to materials studies developed at RCA Laboratories over the past 10 years was used. The technique is based on the synthesis of samples having one or two independent parameters graded over the surface of a planar substrate. Coupled with automated methods of measurements and evaluation of properties it is possible to optimize a given materials system up to several hundred times faster than by conventional methods. The multilayer structure consisted of glass substrate/ITO/Pt-SiO_2 cermet/p^+-i-n^+ a-Si:H/metal. The cells were illuminated through a glass substrate which serves as an encapsulation layer. The following optimum parameters have been determined: thickness of ITO, 580 A; Pt content of the cermet, 10 to 15 vol %; thickness of cermet, 120 A; thicknesses of the p^+-i-n^+ a-Si:H layers, 450 A, 5000 A and 0 to 1000 A, respectively; the deposition temperature of the a-Si:H, 215°C. The a-Si:H deposited by rf capacitive technique contained about 21% H when deposited at this temperature. Cells made with the optimized parameters had an efficiency of 2.9%. This value is lower than the best published results for a-Si:H cells because of the increased absorption and reflection losses of this fully protected cell structure and possible qualitative differences in the a-Si:H materials.

11545 Preparation and properties of nitrogen-doped amorphous silicon. Hack, M.G.; Milne, W.I. (Cambridge Univ., England). pp 278-286 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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Amorphous silicon, grown by an rf sputtering process, has been successfully n-doped using gaseous nitrogen as the dopant. The effect of the addition of nitrogen was to increase the photoconductivity over that of the undoped material but experiments have indicated that, unlike phosphorus doped amorphous silicon, there appears to be no maximum in the photoconductivity for E/sub C/-E/sub F/ $\approx$ 0.64 eV. Photo-induced effects, similar to those found in undoped glow discharge amorphous silicon, have also been found, although the annealing temperature is noticeably lower.

11546 Evaluation of multijunction structures using amorphous Si-Ge alloys. Marfaing, Y. (CNRS, Meudon, France). pp 287-294 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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It is proposed to increase the conversion efficiency of a-Si solar cells by using the amorphous Si-Ge alloy for making stacked multijunction structures. The cascade arrangement of several junctions allows one to increase the overall collection efficiency with respect to a single junction. The conversion efficiencies calculated for two and three junction structures are in the range 12 to 21% well above the 10% threshold value assigned to an all thin film cell. The realization of these structures calls for an appropriate technological effort as well as a basic analysis of tunnel currents in doped amorphous junctions.

11547 Schottky barriers on sputtered hydrogenated amorphous silicon: photovoltaic properties and capacitance-voltage characteristics.

Vieux-Rochaz, L. (Commissariat a l'Energie Atomique, Grenoble, France); Chenevas-Paule, A.; Jousse, D.; Viktorovitch, P. pp 295-302 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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Pt and Au Schottky barrier diodes were achieved on sputtered hydrogenated amorphous silicon (a-Si:H) of large photoconductivity $\mu tau = 10^{-4} cm^2 V^{-1}$). The devices were used to carry out photovoltaic experiments and an electrical characterization of the material. The photovoltaic characteristics of the Pt/a-Si:H diodes are Voc = 700 mV, Jsc = 4 mA/cm², eta = 1.3% under AM1 illumination. Spectral response and I(V) versus temperature measurements gave 0.95 eV for the Schottky barrier height. C(V) capacitance-voltage experiments were carried out in the range 0.2 Hz to 30 kHz. The results indicate a very low density of states around the midgap (D/sub V/ $< 10^{16} cm^{-3} eV^{-1}$). As a conclusion, the material obtained by rf sputtering appears as good a candidate as the one produced by glow discharge for solar energy conversion.

11548 Contact formation, scaling, and optimisation of large-area rf sputtered a-Si Schottky barrier solar-cells. Thompson, M.J.; Alkaisi, M.M.; Allison, J. (Univ. of Sheffield, England). pp 303-311 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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It is now well established that the inclusion of hydrogen in a-Si is responsible for the large reduction in the density of states observed. This paper is concerned with the effect of hydrogenation of rf sputtered a-Si as used in Schottky-barrier solar cells. The temperature dependence of the I-V characteristics is related to the bulk properties of the a-Si prepared in plasmas containing different hydrogen partial pressures. The optimum barrier performance is compared with that for samples prepared in hydrogen above and below the critical hydrogen pressure. Localized state conduction appears responsible for the reduction in Schottky barrier performance. Apparent changes in majority carrier type occur in samples containing high hydrogen concentrations. Devices are described which consists of junctions between a-Si layers containing different quantities of hydrogen. Improved solar-cell performance is obtained when such layers are incorporated. Scaling cells to large areas produces no special problems.

11549 Stability of amorphous silicon Schottky-barrier solar cells. Carlson, D.E.; Magee, C.W. (RCA Labs., Princeton, NJ). pp 312-319 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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The electronic properties of hydrogenated amorphous silicon (a-Si:H) are adversely affected by ion bombardment during the glow discharge deposition of the material. Electron-beam evaporation of Pt Schottky barriers creates defects in a-Si:H due to electron bombardment; the x rays generated during evaporation do not affect the photovoltaic properties. Exposure of Pt Schottky-barrier and MIS cells to water vapor causes a gradual degradation apparently due to the injection of OH^- ions into the space charge region. Water vapor also causes a short-term degradation in MIS cells that can be reversed by a brief heat treatment at 200°C. Encapsulation of both Pt Schottky-barrier and MIS cells is necessary for long-term stability.

11550 Hydrogenated amorphous silicon Schottky-barrier diodes. Ondris, M.; Borst, J. (Univ. of Technology, Delft, Holland). pp 320-326 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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Schottky-barrier structures have been made from hydrogenated amorphous silicon deposited by glow discharge in an rf-excited plasma in silane. These were used to study the influence of the deposition parameters - the temperature, the gas pressure, the rf power, and the geometry of the system - on the electrical properties of hydrogenated a-Si:H. A plate of stainless steel or a nickel-chrome layer evaporated on glass has been used as a substrate. A good ohmic contact between the substrate and the ~ 0.5 μm thick layer of undoped a-Si is obtained by a thin, heavily phosphorous-doped layer. The metal part of the Schottky-barrier diode was a thin layer of gold. Hydrogenated amorphous silicon Schottky-barrier diode have been made wih I-V characteristic approaching ideal diode I-V characteristic and, with diode quality factor close to one. The I-V characteristic is linear over seven decades on the semilogarithmic scale. Also the ratio of forward current to reverse current is very high, about 10^8.

11551 Appraisal of thin-film solar cells. Barnett, A.M. (Univ. of Delaware, Newark). pp 328-343 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

At present there are more than 14 different material systems being actively investigated for potential low cost thin film solar cells. A systematic procedure is described to analyze the potential of each of these materials for energy conversion efficiency. The basis for the procedure is loss minimization: i.e., the selective identification and analysis of those factors which cause power output to fall below the maximum set by available sunlight. This technique can be applied to each of the principal thin film solar cell systems presently being investigated. Application of this methodology leads to a simple analysis of the potential of all thin film systems and clearly specifies which research areas will have the highest probability of success. The superposition of semiconductor materials cost and other maufacturing costs to the loss minimization procedure converges to a systematic analysis of the potential of each material system. Continued progress in the development of low cost thin film solar cells will lead to the demonstration of the feasibility of manufacturing a solar cell which can be sold for $250 per kilowatt (1977 dollars) as early as 1986.

11552 Interface recombination and junction field studies in the Cu_2S-CdS solar cell. Kilgren, L.M. (Univ. of Delaware, Newark). pp 344-351 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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In the Cu_2S-CdS solar cell a significant part of the recombination losses are due to interface states in the junction. A technique has been developed which directly determines the voltage dependence of the interface recombination. An experiment is described which allows one to measure cell response to a modulated monochromatic source while the cell is biased with an applied voltage and illuminated by light of varying spectral content and intensity. Phase-sensitive detection is used to measure the cell response to the modulated source. It has been determined that the light-generated current is a function of the applied voltage. Also, marked differences in the fraction of current lost due to voltage-dependent junction effects have ben noted for cells of differing performance characteristics. For cells of generally good performance characteristics the changes noted as a function of spectral content and intensity of the bias light are in good qualitative agreement with theoretical predictions as well as conclusions inferred from capacitance and current-voltage studies.

11553 EBIC and capacitance measurements on Cu_2S-CdS solar cells: stability problems. Pfisterer, F.; Schock, H.W.; Hewig, G.H. (Univ., Stuttgart, Germany). pp 352-360 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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EBIC and capacitance measurements have been carried out on Cu_2S-CdS solar cells. A special method has been developed to use the EBIC-technique for determining the diffusion length of minority carriers in the polycrystalline CdS- and Cu_2S-layer. For CdS a hole diffusion length L/sub p/ of 0.2 μm has been measured. For Cu_2S the electron diffusion length L/sub n/ depends on the post-fabrication treatment. In well-treated layers L/sub n/ is about 0.3 μm. From capacitance measurements a doping concentration of the CdS-layer of about 1.2 x 10^{17} cm^{-3} is obtained. Additionally values of the parameters of copper diffusion in CdS have been estimated. Theoretical considerations based on the results of the capacitance measurements allowed estimations of the space charge density and the potential distribution in the Cu_2S-CdS heterojunction. Calculations concerning the Cu-diffusion inside the CdS-layer have revealed that interdiffusion of copper at an operating temperature of the cell of 80°C cannot be considered as a degradation mechanism.

11554 Single crystal solar cell heterojunctions by chemical vapor deposition of CdS. Arienzo, M.; Loferski, J.J. (Brown Univ., Providence, RI). pp 361-369 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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A chemical vapor deposition method capable of depositing high quality epitaxial layers of CdS on single crystal substrates has been employed for the fabrication of heterojunction photovoltaic devices of the type n-CdS/p-InP, n-CdS/p-CdTe, n-CdS/p-GaAs, and n-CdS/p-Ge. Analysis of the dark current-voltage characteristics shows the existence in all of the devices of a low temperature, low bias voltage tunneling current. In at least two devices, n-CdS/p-

InP and n-CdS/p-CdTe, there exists, at temperatures equal or higher than 300°K, a tunneling recombination current flow through states near or at the interface with a thermal activation energy in the 0.6 eV range. A model which explains this current has been proposed and the connection between the diode parameters and the mismatch investigated.

11555 Optimal material properties for CdS/Cu_2S solar cells. Rothwarf, A. (Univ. of Delaware, Newark). pp 370-378 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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The properties reported for these cells have shown wide variations in efficiency as well as in phenomena exhibited by the cells. The material properties of cadmium sulfide and copper sulfide have also displayed a wide variety, with significant changes in properties occurring with heat treatment of the materials. A heterojunction model proposed previously accounts for many of the properties of the cell, and has been used to guide modifications of cell production and design to achieve improved efficiency. A review of the model is presented with emphasis on the role of the material properties of the Cu_2S and CdS layers, and experimental confirmation of predicted effects. The combined experimental and theoretical results indicate that the donor density N/sub D/ in CdS and the acceptor density N/sub A/ in Cu_2S are the crucial material properties. Optimal operation of the cell requires N/sub D/ $\approx 10^{16}$ to 10^{17}/cm^3 and N/sub A/ $\approx$ 100 N/sub D/.

11556 Thin film (CdZn)S for solar cells. Hench, T.L.; Hall, R.B. (Univ. of Delaware, Newark). pp 379-386 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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The present junction model for CdS/Cu_2S solar cell devices predicts a greater than one-third increase in conversion efficiencies for (CdZn)S/Cu_2S cells. This expected increase occurs as a consequence of removing the conduction band discontinuity at the interface between Cu_2S and (CdZn)S having the proper zinc concentration. To achieve this level of performance, compositionally homogeneous films with the appropriate electrical resistivity and zinc content are necessary. A concentric source bottle design has been employed to prepare (CdZn)S films which are homogeneous, both in composition and resistivity, over a 7.5 x 7.5 cm^2 area. For zinc concentrations up to 30%, it is possible to achieve the desired electrical resistivity by the proper adjustment of substrate and source temperature, and the orifice sizes in the source bottle. A (CdZn)S/Cu_2S cell fabricated on (CdZn)S prepared with the concentric source was measured to have a short circuit current of 18.7 mA/cm^2 (normalized to 100 mW/cm^2), an open circuit voltage of 579 mV, and conversion efficiency of 7.81%. Analysis of losses in this cell design indicate that further efficiency improvements may be realized by the proper modification of the film structure.

11557 Progress in the development of the thin film MIS solar cell based on CdSe. Bonnet, D. (Battelle Institut e.V., Frankfurt am Main, Germany). pp 387-395 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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Further development of the CdSe MIS thin film solar cell has led to intrinsic efficiencies of around 5% and short-circuit densities of over 20 mA/cm^2 related to 100 mW/cm^2 solar light incident on the semiconductor. Besides ZnSe, only one other insulting material for the I-layer has been found out of 12 different materials, this being Sb_2Se_3 which produced results similar to those of ZnSe. Most CdSe material purchased externally has been found to produce cells inferior to the solar cell made from CdSe synthesized in-house from the elements in very pure form. Further work will concentrate on the improvement of materials, the introduction of doping profiles and the use of transparent contacts.

11558 S.E.M. study of thin films made by spray pyrolysis. Lampkin, C.M. (Photon Power, Inc., El Paso, Texas). pp 396-405 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovoltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Large monolithic solar photovoltaic panels are in initial pilot production at Photon Power (El Paso, Texas USA). These panels utilize CdS deposited by spray pyrolysis with a Cu/sub x/S layer formed by dipping in cuprous ion solution. In order to gain a better understanding of the structure of such films and also in order to assure a basic level of film quality, a field emission scanning electron microscope was used to observe these films. It was necessary to develop specimen preparation techniques which allowed rapid sample cycle time and which could clearly show as many important aspects of film and junction structure as possible. These specimen preparation techniques encompass film fracture for cross sections and differential etching to separate the individual layers in multilayered structures.

11559 CdTe homojunctions solar cells. Lincot, D.; Mimila-Arroyo, J.; Triboulet, R.; Marfaing, Y.; Cohen-Solal, G.; Barbe, M. (CNRS, Meudon, France). pp 424-431 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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Shallow CdTe homojunctions have been prepared by a modified CSVT technique, in which a thin layer of doped CdTe (p or n type) is epitaxially deposited on a single crystal CdTe substrate (n or p type respectively). Their characteristics such as current-voltage dependence in the dark and under AMO illumination, relative spectral responses, and capacity-voltage behavior are presented and discussed. It appears that the high values of surface resistances amount to 0.5 to 10 MΩ are one of the most important limitating factors to obtain valuable efficiencies. Simulated and experimental analysis of surface resistance effects is carried out. Practical expressions are given. It is shown that experimental I-V curve shapes don't come from a voltage dependent quantum efficiency (e.g. variations of the space charge region width, field effects) but are mainly due to surface resistances. In these conditions, generated photocurrent densities of about 25 mA/cm^2 under AMO illumination have been found, and open circuit voltage of about 800 mV, with the same sample. Potential improvements of collect conditions, must give experimental efficiencies of more than 10% for AMO without reflection losses corrections. Two possible solutions are reported.

11560 Oxide/semiconductor photovoltaic heterojunctions based on CdTe or InP. Bube, R.H.; Courreges, F.G.; Fahrenbruch, A.L.; Tsai, M.J. (Stanford Univ., CA). pp 432-439 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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The properties of oxide/semiconductor surfaces and interfaces have been investigated using indium-tin oxide as the large bandgap member of the heterojunction, deposited by rf sputtering on single crystal substrates of p-type CdTe or InP. Solar efficiencies of 8% have been achieved for such ITO/CdTe cells, and of 12% for ITO/InP cells. Since there is considerable lattice mismatch between the compounds in these two heterostructures, it is of interest to evaluate the reasons for the relatively high values of efficiency obtained. The results of measurements on In/CdTe and Au/InP Schottky barriers, on ITO/CdTe and ITO/InP heterojunctions, and on the surface properties of CdTe or InP by photoluminescence and surface photovoltage measurements, all indicate the formation of an n-type surface layer as the result of sputtering damage with the resultant formation of a homojunction. The existence and electronic properties of this surface layer have been directly verified by Hall effect and thermoelectric power measurements on sputter-etched surfaces of InP. Correlating results are obtained by surface photovoltage measurements on CdTe, which indicate that the bands at the surface bend down for a chemically polished surface, but bend up for a sputter-etched surface. ITO/InP results are reproduced using sputtered films of In_2O_3, SnO_2, ZnO, or CdO. Effects of heat treatment and/or degradation with time are associated with the conversion of the sputtering-caused homojunction into a heterojunction.

11561 Concentration and temperature performances of GaAs-GaAlAs solar cells. Fanetti, E.; Fiorito, G.; Flores, C. (CISE Spa, Milan, Italy). pp 447-454 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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GaAs-GaAlAs solar cells have been grown by LPE technique. Particular attention was paid to the adjustment of the parameters affecting the series resistance such as layer doping and thickness, and contact pattern design. The conversion efficiency of some solar cells was measured up to 1000 suns. We have determined the temperature dependence of the open circuit voltage (V/sub oc/), the short circuit current (I/sub sc/), the fill factor (FF) and the efficiency. The experimental data were compared with the theoretical curves. The series resistance reduction is still the main goal in order to achieve solar cells to be used in high concentration hybrid systems.

11562 Pulsed measurement of solar cell spectral response. Larue, J.C. (European Space Research and Technology Centre, Noordwijk, Netherlands). pp 477-486 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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The measurement of solar cells spectral response provides many useful data on the device characteristics. It may also be used to compute Isc for different sunlight spectra, and thus to generate artificial reference standards. The accuracy, however, is often reduced because of physical and practical limitations related to the low illumination level provided by usual monochromatic light sources. In the present work, the problem of illumination intensity was overcome by using a powerful photography flash-lamp as a light source together with the customary set of narrow band-pass interference filters. Otherwise, the method remains based on the comparison between short circuit currents generated respectively by the test cell and by a spectrally calibrated reference cell. The validity of the method has been verified in two ways: first by cross checking spectrally calibrated reference standards; second by computing short-circuit currents of 10 test cells from the spectral response measured and AM0 and AM1.5 sunlight spectral distribution, and subsequent comparison to Malta sunlight calibration data. In both cases, the accuracy obtained was in the range +- 2%. A complete practical description of the test set-up is given together with its present shortcomings and planned improvement. It is believed that this approach will lead to a semi-automated spectral response measurement facility, which being both accurate and simple to use will extend the field of application of this type of measurement.

11563 Low cost solar simulator for testing photovoltaic terrestrial solar power cells and modules. Haigh, A.D.; Shaw, I.M. (Ferranti Electronics Ltd., Manchester, England). pp 487-494 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Plaz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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Large area pulsed solar simulators (LAPSS) have become the preferred method of testing the electrical output of arrays of photovoltaic cells used to power artificial satellites. Such facilities exist at major manufacturers of these arrays and at the test houses of space agencies, but they are expensive to establish and operate. The paper details the design and describes the construction of a table top, pulsed solar simulator (TTPSS) built at a fraction of the cost of a LAPSS. A close approximation to air mass one (AM1) spectral content and irradiance is simulated over a test area of 600 mm square, each pulse of radiation measuring a point on the device I-V characteristic. The simulator has been shown to reproduce closely device characteristics measured on the LAPSS at RAE Farnborough. Space requirements are minimal, and the low cost of building and operating, removes the economic constraints for many potential users of this test method. Measurement of spectral content reveals interesting variations in the power distribution, between line and continuous spectra, as the xenon arc decays. Further developments are also discussed of a larger simulator with an electronic load, high injection level spectral response measurements and automated testing.

11564 Photovoltaic generators using optical concentration. Mertens, R. (Katholieke Univ. Leuven, Heverlee, Belgium). pp 496-506 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Plaz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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A review of the current status and the trends in the development of photovoltaic systems with optical concentration is given. There are no fundamental reasons preventing the possible success of the concentration concept. Several prototypes, using conventional geometrical optics and Si solar cells, seem to be able to reach the 1982 $2 Watt cost goal. The actual global efficiency of these systems lies around 9%. To obtain the break even point for central utility applications considerable higher efficiencies are necessary. The use of the multi-cell concept in which two (or more) cells with a different bandgap are present within the same concentrator allows the achievement of these very high efficiencies. The final assessment of the concentration approach only can be performed by the construction of sufficiently large prototypes.

11565 Operation of multi-bandgap concentrator cells with a spectrum splitting filter. Vander Plas, H.A.; Moon, R.L.; James, L.W.; Yep, T.O.; Fulks, R.R. (Varian Associates, Inc., Palo Alto, CA). pp 507-514 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Plaz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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Attainment of photovoltaic conversion efficiencies greater than 25% to 30%, thought necessary to make concentrator photovoltaics economical, seems possible if the solar spectrum is more efficiently used by splitting the spectrum and using solar cells of different bandgaps. For initial work on multi-bandgap concentrator solar cells, the spectrum has been split by an optical filter which transmits light above 1.6 eV and below 1.1 eV and reflects light between 1.1 and 1.6 eV. Theoretical modeling of possible conversion efficiencies led to the choice of the filter bandpass energies and practical solar cell fabrication considerations has led to the choice of silicon and the Al/sub x/Ga/sub 1-x/As system for initial development work. Special silicon concentrator solar cells with a $p^+:n^-:n^+$ structure have been designed for this application and have attained apparent cell conversion efficiencies of 16.2% at a current ratio of 455 suns. An $Al_{0.93}Ga_{0.07}As/Al_{0.17}Ga_{0.83}As$ solar cell with a bandgap near 1.6 eV has attained a cell conversion efficiency of 20.4% at a flux concentration of 525 suns. These cells have been packaged and combined with the spectrum splitting filter to give conversion efficiencies at 50°C, including the filter and the cells, of 27.0% at 113 suns and 26.0% at 489 suns.

11566 Solar cells with concentrating collectors and integrated heat use system. Simon, M.; Pfeiffer, H.; Kohlmannsperger, J.; Gall, S. (Maschinenfabrik Augsburg-Nuernberg Aktiengesellschaft, Muenchen, Germany). pp 541-549 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

The development work for a 4 kW/sub e/ Concentrating Silicon Cell Module with 4 heliostatic mounted cylinder parabolic troughs and concentration factor of 20 to 40 is presented. A model calculation for the optimization of the concentration factor is presented first. Depending on the future development of the specific cell costs and specific collector costs a concentration between 10 to 50 will be optimal. The climate compels the construction of an indoor test facility with a simulated sun. Cell modules with one meter length will be tested under cell temperatures ranging from 20° up to 120°C and concentration factors of 20 to 40, to optimize the system parameter. Selected measures are checked in outdoor tests of preprototype consisting of one trough of 4 m length and a complete 4 m cell module with a concentration of 20 and a load simulator water pump. The preparation work for a prototype is presented with the modular 4 trough collector system which is optimized for maximum daily energy output, low series production and maintenance cost and long service time. The development of an integrated heat use system which will use a selective filter mirror to concentrate radiation not usable by the cells onto a secondary high temperature heat absorber sub-system is described.

11567 Photovoltaics on the system level. Lindmayer, J. (Solarex Corp., Rockville, MD). pp 563-569 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

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It is a fact of life that silicon cells have now reached the system level. An attempt is being made to outline the future system directions in its present early stages. It is recognized that silicon cells are available in almost geometrically increasing quantities and their cost is being reduced by the volume, according to an experience curve. As the cost of the solar cell component drops the balance-of-system cost is becoming an equal factor and the system approach is dispersed. Directions in systems will solidify in the coming years as new, larger, more efficient and less expensive components, such as semicrystalline cells, will be available.

11568 Batteries for solar electricity. Jensen, J. (Odense Univ., Denmark); Perram, C.; Dell, R.M. pp 610-620 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The small scale storage of solar electricity in situations where no mains back-up supply is available is considered. A systems optimization study of the solar cell/battery includes an analysis of solar cell size related to battery capacity for given insolation patterns and load constraints. Various candidate batteries are reviewed. Apart from cost the following parameters are generally important: low maintenance, long lifetime and large number of cycles, high charge/discharge efficiency, and good charge retention. Sealed lead-acid and nickel-cadmium batteries are the only options at present. In the medium term it is possible that nickel-zinc and lithium-organic electrolyte batteries will also have a role to play. It is concluded that in the long term an all solid state, maintenance free low cost battery is needed.

11569 Numerical modelling of a solar cell in three dimensions. Calzolari, P.U. (Univ., Bologna, Italy); Mazzone, A.M. pp 631-638 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A numerical analysis in three dimensions of comb-shaped cells is presented. The main assumptions are the equipotentiality of bus bar and the gradual variation of photovoltage on the surface.

The range of grid parameters here considered covers the features of both standard evaporated and screenprinted cells. The approach has been used to investigate the ultimate possibilities of both in the low-medium concentration range.

11570 Reduction of surface recombination velocity of silicon surfaces by SnO/sub x/ films. Chambouleyron, I.; Saucedo, E.; Montoya, J. (CIEA-IPN, Mexico City, Mexico). pp 647-653 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Structural, optical, and electrical characteristics of SnO/sub x/ films obtained by the chemical spray method and the passivation effect which they provoke when deposited on conventional Si solar cells are reported. Experimental work was carried out to elucidate the actual influence of H and Cl atoms, liberated during the deposition process, at the SnO/sub x/-Si interface. Atomic hydrogen is shown to play the main role in Si surface passivation. It has been found by SIMS analysis that hydrogen diffuses in the silicon lattice after SnO/sub x/ deposition. This fact might produce changes in the transport properties of the diffused region of silicon solar cells and contribute to the large increases in short circuit current found after coating.

11571 Theoretical performance of multi-layer grid patterns for solar cells. Flat, A.; Milnes, A.G. (Carnegie-Mellon Univ., Pittsburgh, PA). pp 654-661 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Multi-layer grid patterns consist of fine closely-spaced grid lines overlaid by coarser patterns of wider and thicker grid lines to collect the current from the finer grids with low series voltage drop and low active-layer sheet losses. An analytical approach leads to closed form solutions with simple relationships between the power losses in the active layer, in the grid and shadowing losses for optimum design proportions. The results show that multi-layer grids, with line thickness equal to line width, greatly reduce losses in cell efficiency under concentration conditions of high current collection. (AlGa)As-pn GaAs cells of areas 1-25 cm^2 and sheet resistance 40 ohms/square are considered. Also the performance of a n/p GaAs cell of dimensions 10 cm x 10 cm is studied. With optimized grid patterns high efficiencies are predicted for large area cells.

11572 Survey of semiconductor combinations for optimum heterojunction thin film solar cells. Vanhoutte, G.; Pauwels, H. (Univ. of Ghent, Belgium). pp 662-670 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

It is investigated which combinations of semiconductors can, in principle, give rise to good heterojunction solar cells that can completely be realized in thin film technology, and it is verified which of these combinations have already been investigated in the literature, and which not. The heterojunctions are classified according to the discontinuities at the interface in the conduction or valence band. Only those semiconductors are considered that can be realized in purely thin film technology with the appropriate type and value of conductivity (p,p^+, n or n^+), although thin film technology may for some of them not yet be sufficiently advanced to realize high collection efficiency. A total number of 15 semiconductors are considered in this way, of which 8 can act as absorber, giving rise to 120 combinations, which are then considered in 6 different types of structures. Those structures that form near optimum solar cells, and those that have already been investigated in the literature are indicated.

11573 Schottky barrier grid devices on Zn_3P_2. Catalano, A.; Masi, J.V.; Wyeth, N.C. (Univ. of Delaware, Newark). pp 440-446 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Schottky barrier grid devices have been prepared on Zn_3P_2 single crystals and their performance evaluated. The device geometry consists of uniformly separated magnesium lines acting as the Schottky barrier grid. The minority carrier transport equations governing carrier collection have been developed and are solved analytically as a function of line separation and diffusion length. The fit between the model and experiment is good. A 6.08% total area (7.6% active area) device has been fabricated using the Schottky barrier grid geometry. The spectral response of the devices has been measured and shows minimal blue fall off, indicating a low surface recombination velocity.

11574 Solar cell module assembly jig. Ofarrell, H.W. US Patent 3,262,694. 26 Jul 1966. Filed date 10 Jun 1963. 8p.

The invention relates to the manufacture of solar cell modules and, more particularly, to a jig for assembling, positioning and maintaining the components under resilient pressure, while the entire assembly and the jig is subjected to heat for simultaneously soldering all of the various circuit connections, as well as structurally bonding the layers into a strong light weight structure which minimizes the tendency of the solar cells to crack and the other components and electrical connections to fracture.

THERMIONIC AND THERMOELECTRIC CONVERSION

11575 Direct energy conversions of solar energy. Rahman, A.A. (Oakland Univ., Rochester, MI). pp 147-154 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

The design concepts of three direct energy converters are explained. The converters selected were thermoelectric, thermionic and magnetohydrodynamic converters. Discussions and analysis of the material limitations of these connverters with possible improvements to make these devices suitable for domestic or public use are also explained.

BIOMASS PRODUCTION AND CONVERSION

REFER ALSO TO CITATION(S) 11081, 11411, 11412, 11413, 11414, 11415, 11416, 11417, 11419, 11420, 11583, 12546, 12551, 12584, 12585, 12591, 12592, 12593

11576 (BMI—2031(Vol.2)) **Carbohydrate crops as a renewable resource for fuels production. Volume II. Identification of key policy issues, alternatives, and implications relating energy from biomass.** Scantland, D.A.; McClure, T.A.; Lipinsky, E.S. (Battelle Columbus Labs., OH (USA)). 30 May 1979. Contract W-7405-ENG-92. 75p. Dep. NTIS, PC A04/MF A01.

The objectives of this research program were threefold: Provide a brief summary assessment of current and developing technologies utilizing carbohydrate crops as potential energy resources; provide an economic analysis of current agricultural policies and their implications concerning the potential use of the carbohydrate crops as biomass energy sources; and identify and examine alternative policies for stimulating biomass production for fuel uses. The conclusions of this preliminary analysis of policy implications suggest the following: (1) Significant quantities of ethanol from carbohydrate crops could be produced from the equivalent number of dollars currently diverted and expected to be spent under the Food and Agriculture Act of 1977 (FAA-'77). (2) However, the production of ethanol from sugar crops or corn would mean that significant changes in the prices of agricultural products could be expected (all other things being equal). (3) In the initial development of ethanol fuels, ethanol from corn appears to be the least expensive as compared to sugarcane, sugar beets, and sweet sorghum. This is primarily because of high by-product credits. However, the crop with the greatest long-term potential is sweet sorghum. (4) Various policy incentive programs will continue to be directed towards stimulating biomass energy production. Several incentive systems already have been recommended in Congress and among the states. Key among these is the present waiver of the Federal Excise Tax through 1984 on gasohol. Battelle has cited a number of potential incentive programs. Each incentive will tend to stimulate different areas of biomass and fuels production. Also, the programs likely will have secondary impacts on other segments of the U.S. agricultural sector. Four policy incentive programs are described in detail.

11577 (DOE/AL/11768—T1) **Report of the Advisory Committee on Agriculturally Derived Fuels to the Texas Energy and Natural Resources Advisory Council.** (Texas Energy and Natural Resources Advisory Council, Austin (USA)). 3 Sep 1979. Contract FG04-79AL11768. 110p. Dep. NTIS, PC A06/MF A01.

For the purpose of the Committee, biomass was defined as the volume of living material or residues of living material (organic material) available in Texas for conversion into energy. Statistical reports from the Texas Agricultural Experiment Station and other sources indicate that in addition to surplus and distressed grains and certain other crops, there are roughly 27 million tons of agricultural residues currently being left in the fields or at the processing plants after harvest. The average annual residue from five crops - sorghum, corn, wheat, rice and cotton - is more than 20 million tons with a theoretical heat value of 270 trillion Btus. This represents 64 percent of the total energy input for Texas agriculture in 1973. Additionally, 4.1 million tons of dry manure is economically recoverable from Texas feedlots which could be converted into 14 trillion Btus of energy each year in the form of methane gas. Municipal solid waste, much of which is comprised of residues of living materials, currently amounts to about 13 million tons annually. The principal processes for converting the referenced resources into energy include: (1)

direct combustion; (2) fermentation; (3) gasification/pyrolysis; (4) anaerobic digestion; and (5) petroculture - the production of certain non-traditional plants. Texas produces huge quantities of biomass, and has the potential of producing even more, which can be converted through various processes into significant quantities of usable energy to help meet the needs of the agricultural industry and the general public. Some of the technology required for the conversion processes is already sufficiently advanced to support immediate production and use while others will require additional research and development. The report discusses the current level of development of the relevant technologies and an estimate of the potential contribution each can make as alternate sources of energy in Texas. Recommendations were made.

11578 (JPRS—74185) **China report: agriculture, No. 53.** 17 Sep 1979. Translation of various articles. 11p. NTIS.

This serial report contains information on agricultural activities in China. The use of methane as energy for agriculture is discussed. The construction of numerous methane pits and the construction of 29 experimental methane electric power stations is described.

11579 (SERI/RR—353-354) **Agricultural crop residue collection costs.** Dauve, J.; Flaim, S.J. (Solar Energy Research Inst., Golden, CO (USA)). Dec 1979. Contract EG-77-C-01-4042. 26p. Dep. NTIS, PC A03/MF A01.

Five different systems for collecting agricultural crop residues are examined: conventional bales, big round bales, big rectangular bales, stackwagons, and loose chop. The stackwagon system had the lowest costs per ton for both a 400-acre corn harvest and a 750-acre wheat harvest. Big round bales are less expensive than the stackwagon system under certain circumstances. Big rectangular bales are competitive when larger acreages are harvested. Conventional bales appear competitive on small acreages where on-farm labor is not a constraint. Loose-chop harvesting systems are not feasible unless transportation distances are short. Custom rates for three systems (conventional bale, big round bale, and stackwagons) are examined to confirm the ordinate ranking of system costs. The custom rates and cost estimates are based on farms located in central Iowa and central Oklahoma, the sample farming situations that are examined in other research in the Analysis Division of SERI. Costs only represent costs for new equipment. These estimates do not represent average charges for the existing stock of harvesting equipment and do not reflect opportunity costs for other farm activities.

11580 **Research, development, and commercialization activities on biomass energy in the United States.** Klass, D.L. Chicago, IL; Institute of Gas Technology (1979). 13p. (NP—24206).

Research and development activities in the United States on the production of energy products and synthetic fuels from organic wastes and land- and water-based biomass are growing rapidly. Commercialization of the results of this effort is also progressing but at a lower rate. Commercial plants are currently operating to produce steam and electric power by combustion or combustion of municipal solid wastes, agricultural residues, and wood; methane from landfills and cattle manure; and fermentation alcohol for use in gasohol blends. Available fossil fuels are still sufficiently low in cost in the United States to make the economics of producing substitute fuels from biomass borderline or unattractive. Large-scale integrated biomass energy systems are therefore not expected to be constructed and operated until the late 1980's and early 1990's. Nevertheless, about 2.1% of the US total energy supply is now derived from biomass; this corresponds to about 1.7×10^{15} Btu.

11581 **Combustion characteristics of hogged Douglas-fir bark in spreader stoker boilers.** Junge, D.C. Corvallis, OR; Oregon State University (1977). 41p.

Initial results are summarized of studies of combustion characteristics of Douglas-fir bark (hogged fuel) as burned in a spreader stoker experimental test facility. Attempts were made to determine combustion characteristics for fuels burned in controlled conditions. Independent variables include wood size and MC, underfire/overfire air ratios, and fuel-to-air ratios. The work is presently under way at Oregon State University in a water wall spreader-stoker with a 10 ft^2 grate.

PHOTOCHEMICAL AND THERMOCHEMICAL CONVERSION

REFER ALSO TO CITATION(S) 11402, 11673, 12247

11582 (COO—4178-3) **Photochemical energy storage: studies of inorganic photoassistance agents. Progress report, December 11, 1978-March 31, 1980.** Wrighton, M.S. (Massachusetts Inst. of Tech., Cambridge (USA)). Dec 1979. Contract EY-76-S-02-4178. 23p. Dep. NTIS, PC A02/MF A01.

Research has focused on the study of chemically derivatized photoelectrodes for conversion of light to electricity or fuels. Examples of completed research are given in the list of publications. Highlights of the period include (i) study of the derivatized n-type Si photoanode for oxidation of water soluble species such as I^-, $Fe(CN)_6^{4-}$, and $Ru(NH_3)_6^{2+}$; (ii) demonstration that heterogeneous electron transfer rates between a surface-confined, photogenerated reagent and a solution reagent can be measured; (iii) demonstration that Fermi level pinning obtains for p-type semiconductors such as Si, GaAs, and InP; (iv) strained Si-C bonds can be used to functionalize surfaces; and (v) study of catalysis of H_2 evolution from illuminated p-type semiconductors.

11583 (SAND—79-8636) **Overall efficiencies for conversion of solar energy to a chemical fuel.** Fish, J.D. (Sandia Labs., Livermore, CA (USA)). 1979. Contract EY-76-C-04-0789. 22p. (CONF-791204—9). Dep. NTIS, PC A02/MF A01.

From 2. Miami international conference on alternative energy sources; Miami Beach, FL, USA (10 Dec 1979).

A complete and consistent schema for determining the overall efficiency of a generalized process for the conversion of solar energy into a chemical fuel is developed and applied to seven conversion processes: conversion of concentrated sunlight to electricity in a conventional thermal cycle followed by hydrogen production via water electrolysis; thermochemical conversion with concentrated solar energy as the heat source; photovoltaic conversion to electricity followed by water electrolysis; photogalvanic conversion to electricity followed by water electrolysis; direct photoelectrolysis of water; natural photosynthesis followed by pyrolysis or digestion of the biomass to convert it to a more convenient form; and direct photochemical production of hydrogen or some other chemical that is capable of undergoing exothermic conversion back to the starting material. It is demonstrated that the overall efficiency of each of these processes is determined by ten common factors; maximum theoretical efficiency; inherent absorption losses; inherent internal losses; rate limiting effects; reflection losses; transmission losses; coverage losses; system construction requirements; parasitic losses; and harvesting and conversion losses. Both state-of-the-art and optimistic values are assigned to each factor for each of the seven conversion processes. State-of-the-art overall efficiencies range from 5% for thermal conversion down to essentially zero for the undeveloped thermochemical and quantum processes. Optimistic values for overall efficiencies in the range of ~ 10 to 15% are calculated for several of the processes. Finally, candidate areas for research are identified by comparing state-of-the-art and limiting values for both the individual factors and the overall efficiencies. 41 references.

11584 (SERI/TP—332-476) **Biological solar cells.** Seibert, M.; Janzen, A.F. (Solar Energy Research Inst., Golden, CO (USA); Photochemical Research Associates, Inc., London, Ontario (Canada)). Nov 1979. Contract EG-77-C-01-4042. 7p. (CONF-791204—7). Dep. NTIS, PC A02/MF A01.

From 2. Miami international conference on alternative energy sources; Miami Beach, FL, USA (10 Dec 1979).

Recent reports have demonstrated the possibility of employing photoactive, biological membrane components in photoelectrochemical cells. Such systems have produced small photovoltages and photocurrents. Present studies in our laboratories have led to the attachment of a much simpler biological complex, the bacterial photosynthetic reaction center isolated from Rhodopseudomonas sphaeroides, directly onto an SnO_2 electrode. The light-induced primary charge separation processes which occur across the reaction center macromolecule have been coupled to the electrode, and in a two-electrode configuration photovoltages as high as 70 mV and photocurrents as high as 0.5 $\mu A/cm^2$ have been observed in an external circuit. The phenomena are not due to biological Dember effects. Such reaction center electrodes may be the forerunner of future biological solar cells or may serve as model systems for future organic photovoltaic devices.

11585 **7.3% efficient thin-film, polycrystalline n-GaAs semiconductor liquid junction solar cell.** Heller, A. (Bell Labs., Murray Hill, NJ); Miller, B.; Chu, S.S.; Lee, Y.T. Contract EG-77-C-01-4042. *J. Am. Chem. Soc.;* **101**: No. 25, 7633-7634(5 Dec 1979).

By elimination of grain boundary effects, it is possible to approach single-crystal efficiency provided that the mobility remains high and an optimal, uniform doping level is maintained throughout the grains. Such a situation is approached in thin-film, chemically vapor deposited n-GaAs, following exposure to a Ru(III) solution. The anode used was n-GaAs/n^+-GaAs/W/graphite. A 24-μm thick layer of n-GaAs was deposited on a 2 to 3-μm tungsten-on-POCO graphite substrate by the reaction by hydrogen chloride, gallium, and arsine at 775°C. The grains were of 1 to 20 μm diameter, with an average linear dimension of 9 μm. The measurements were done under 96.4 mW/cm^2 incident sunlight. The insolation was determined by an Eppley Model PSP radiometer, which measures the direct and scattered insolation from the entire sky. This demonstrates that grain-boundary diffusion of a strongly bound impurity can reduce the grain-boundary-related losses in solar cells made with thin-film polycrystalline semiconductors. This work suggests that it is possible to approach more closely single-crystal efficiencies in

thin-film polycrystalline solar cells than originally thought. 2 figures. (DP)

11586 Semiconductor-electrolyte solar cells for the photoelectrochemical reduction of carbon dioxide to organic fuel. Halmann, H.; Aurian-Blajeni, B. (Weizmann Inst. of Science, Rehovot, Israel). pp 682-689 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The reduction of carbon dioxide in aqueous media to organic compounds was achieved both by photoelectrochemical reaction on p-type semiconductor electrodes and by photocatalytic reduction on suspensions of powdered semiconductors. In the photoelectrochemical reduction, p-gallium phosphide or p-gallium arsenide were used as photocathodes, while carbon or n-TiO_2 were used as the anode. A measurable photocurrent was obtained by applying a cathodic bias to the photocathode. Using p-GaP, with monochromatic light of 365 nm (incident light intensity 2.4 mW/cm^2), and an electrical bias of -0.9V, the efficiency for conversion of optical to chemical energy of the organic products was 3 to 5%, corresponding to solar energy conversion efficiencies of 0.6 to 0.9%. The products identified by chemical analysis were formic acid, formaldehyde and methanol. Improved stability of the p-GaP electrode was obtained by operation at a temperature of 70 to 90°C. In the photocatalytic reaction, aqueous suspensions of various oxide semiconductors were irradiated either with sunlight or with a high-pressure Hg-lamp. Significant reduction of carbon dioxide was achieved using various activated preparations of TiO_2, Fe_2O_3, WO_3, ZnO, as well as with a clay mineral, nontronite. Products identified were formaldehyde, methanol, and methane.

11587 Electrochemical photovoltaic cells utilizing thin film semiconductor electrodes. Russak, M.A. (Grumman Aerospace Corp., Bethpage, NY); Reichman, J.; Witzke, H.; Deb, S.K.; Chen, S.N. pp 690-700 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz,W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Electrochemical photovoltaic cells rely on the junction formed between a semiconductor and electrolyte to accomplish photovoltaic conversion. The fabrication and evaluation of thin film CdSe electrodes for use in these cells are described. The effect of electrode preparation and electrolyte concentration on efficiency and stability are presented. I-V curves and action spectra are also discussed and a correlation between efficiency and minority carrier diffusion length is shown. Conversion efficiencies as high as 5% are reported.

11588 Photoelectrochemical solar cells. Gerischer, H. (Max-Planck-Gesellschaft, Berlin, Germany). pp 408-423 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The energy conversion mechanism in photosynthesis which is based on a photoelectrochemical process is briefly discussed in order to ask whether technical devices can be developed along similar lines. A comparison of this system with other approaches to energy conversion by photoelectrochemical reactions indicates that a photosynthesis like device has little chance of reaching high efficiency at reasonable cost. The best prospects can be attributed to cells with semiconductor/redox electrolyte junctions in which a Schottky barrier is formed due to suitable differences in the work functions (position of the Fermi level before contact is made). The function of such systems is described and some examples are presented. The most serious problem is the protection of the semiconductor against photocorrosion. Attempts to overcome this problem are discussed. Finally it is considered whether immediate storage of the energy in the products of photoelectrolysis is preferable to separate photovoltaic power generation with consecutive storage by normal electrolysis. (54 references)

PHOTOVOLTAIC POWER PLANTS

REFER ALSO TO CITATION(S) 11456, 11516, 11522, 11642, 11965

11589 (AD-A—068365) Economic analysis of solar photovoltaics for low-power lighted aids to navigation. Final report. Allen, W.R. (Coast Guard Research and Development Center, Groton, CT (USA)). Jun 1978. 53p. NTIS, PC A04/MF A01.

A detailed economic analysis with decision-making criteria for converting the present energy storage system used on U.S. Coast Guard low-power lighted aids to navigation to one that relies upon conversion of solar energy by photovoltaics is presented. The analysis demonstrates that converting 12-volt lighted aids to navigation from reliance on primary air-cell batteries to reliance on solar photovoltaics is attractive from an economic point of view. However, questions concerning reliability and life must be answered before the Coast Guard plans conversion to solar photovoltaics.

11590 (ALO—4261-T8) Assessment of the technology transfer potential of federal photovoltaic power system applications to commercial markets. Final report. Jaras, T.F. (Science Applications, Inc., McLean, VA (USA)). Jun 1979. Contract EM-78-C-04-4261. 153p. Dep. NTIS, PC A08/MF A01.

An assessment of the market potential of photovoltaic power supplies is presented. Markets analyzed include the water pumping market, marine navigational aids, cathodic protection, remote general power sources, telecommunications, air navigational aids, mobile generator market, instrumentation, and utility connected applications.

11591 (COO—4094-60) Solar Photovoltaic Project: materials, processes, and testing activities. Quarterly report, April 1-June 30, 1979. Forman, S.E.; Themelis, M.P. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 31 Oct 1979. Contract EY-76-C-02-4094. 36p. Dep. NTIS, PC A03/MF A01.

The US Department of Energy has set a 20-year lifetime goal for terrestrial photovoltaic modules. In its capacity as a Photovoltaic Field Tests and Applications Center, Massachusetts Institute of Technology Lincoln Laboratory has established various experimental test sites, ranging in size from 0.1- to 25-kW-peak power, throughout the United States. These sites include modules from several manufacturers and serve as test beds for photovoltaic system components. This report, the fifth in a series of similar reports (1-4), summarizes the activities of the Materials, Processes and Testing Laboratory of the Solar Photovoltaic Field Tests and Applications Project during the three-month period (4/1/79 to 6/30/79). During this period, inspection trips were made to test sites at the University of Texas at Arlington and at Mead, Nebraska. Modules were tested in the field to determine the extent of physical and electrical degradation which had taken place since previous inspections. Several modules were removed from these sites for more detailed laboratory analysis. In addition, degradation analysis of modules from the rooftop of the Chicago Museum of Science and Industry, and failure analysis of modules from the Lincoln Laboratory Rooftop Test Bed and Residential Test Beds was performed. The results of both field testing and the laboratory analyses are reported.

11592 (COO—4094-68) Photovoltaic powered 20-hp DC/AC irrigation system and a 3-kW nitrogen generator. Hopkinson, R.F. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1980. Contract EY-76-C-02-4094. 6p. (CONF-800106—22). Dep. NTIS, PC A02/MF A01.

From 14. photovoltaics specialists conference; San Diego, CA, USA (7 Jan 1980).

A 25-kWp photovoltaic power system has been providing power for irrigation and crop drying since July 1977 at an agricultural field station of the University of Nebraska, located at Mead, Nebraska. The system was designed and built by Massachusetts Institute of Technology's Lincoln Laboratory under US Department of Energy sponsorship and is being operated jointly by the university and MIT Lincoln Laboratory. The system consists of a 25-kWp PV array, a battery subsystem, a power dump, an inverter, a controller and a data acquisition system. This photovoltaic power system has been used as a test facility in order to test and evaluate a variety of PV-related agricultural applications, including irrigation, crop drying and fertilizer manufacturing. Two interesting applications presently under evaluation are a 20-hp DC/AC-powered irrigation system and an on-site nitrogen fertilizer production unit.

11593 (COO—4094-69) Performance and reliability of photovoltaic modules at various MIT LL test sites. Forman, S.E.; Themelis, M.P. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1980. Contract EY-76-C-02-4094. 6p. (CONF-800106—21). Dep. NTIS, PC A02/MF A01.

From 14. photovoltaics specialists conference; San Diego, CA, USA (7 Jan 1980).

Between March 1977 and the present, MIT Lincoln Laboratory, in conjunction with the US Department of Energy, has placed 85 kW of photovoltaic modules at various experimental test sites in the United States. These sites range in size and function from a 25-kW System Test Facility, where all the components in a PV system are tested, down to a 0.1-kW Environmental Test Site, where modules alone undergo weathering and soil accumulation experiments. To date, 144 modules (amounting to 2.75 kW) of 4533 have experienced electrical failure. This report summarizes the performance and reliability of photovoltaic modules at two experimental test sites: a 25-kW array field at Mead, Nebraska, and a 7.5-kW array field at Arlington, Texas.

11594 (COO—4094-72) Energy balance associated with the use of a maximum power tracer in a 100-kW-peak power system. Bucciar-

elli, L.L.; Grossman, B.L.; Lyon, E.F.; Rasmussen, N.E. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1980. Contract EY-76-C-02-4094. 5p. (CONF-800106—16). Dep. NTIS, PC A02/MF A01.

From 14. photovoltaics specialists conference; San Diego, CA, USA (7 Jan 1980).

Design of a stand-alone photovoltaic (PV) system which includes batteries for energy storage requires not only sizing the array power output and battery storage capacity to meet the load, but also fixing the number of battery cells placed in series relative to the number of PV cells in series in order to keep the battery voltage in the neighborhood of the array maximum-power-point voltage during operation. When a maximum-power-point tracker (MPPT) is interposed between the array and the battery, the design task is simplified. The decision to use an MPPT depends primarily on the operating efficiency of the device. The recent development at MIT Lincoln Laboratory of low-cost maximum-power-point trackers capable of efficiencies greater than 98% at the 3-kW level broadens the range of applications where an MPPT can be used to advantage. Hourly simulation results for the 100-kW-peak PV stand-alone system under construction at Natural Bridges National Monument in Utah are compared for the cases with and without maximum power tracking to quantify the advantage of MPPT implementation.

11595 (COO—4094-75) **Residential system designs for the northeast and southwest.** Russell, M.C. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1980. Contract EY-76-C-02-4094. 4p. (CONF-800106—13). Dep. NTIS, PC A02/MF A01.

From 14. photovoltaics specialists conference; San Diego, CA, USA (7 Jan 1980).

The development of residential photovoltaic power systems as part of the United States Department of Energy photovoltaic program will begin in FY-80. Prototype residential systems for heating, cooling and electric power will be built and evaluated at regional Residential Experiment Stations (RES's). The first RES locations will be in the Northeast and Southwest. The most appropriate system designs for Northeast and Southwest residences have been identified in various studies. Photovoltaic collector systems will be fielded in both the Northeast and Southwest RES facilities. A utility-interactive direct current to alternating current power inverter will be used with no on-site electrical storage. Similar systems using either combined photovoltaic/thermal collectors or separate photovoltaic modules and solar thermal collectors will be fielded at the Northeast RES facility.

11596 (COO—4094-78) **Microprocessor-based control of the photovoltaic solar power system for an AM radio station.** Much, C.H.; Rothenheber, P.J. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1980. Contract EY-76-C-02-4094. 7p. (CONF-800306—3). Dep. NTIS, PC A02/MF A01.

From International IECI conference; Philadelphia, PA, USA (17 Mar 1980).

A microprocessor-based controller for a 15 kW photovoltaic power system powering an AM radio station keeps dc bus voltage between desired limits, governs battery operation, monitors safety conditions, and provides status reporting. The microprocessor also facilitates complicated algorithms that improve performance. The first three months of system operation are presented.

11597 (DOE/CS/05312—1) **Photovoltaic Concentrator System for Roxborough Park. Final report, June 1978-28 February 1979.** Donovan, R.L. (Martin Marietta Corp., Denver, CO (USA)). Mar 1979. Contract ET-78-C-04-5312. 138p. Dep. NTIS, PC A07/MF A01.

The conceptual design of a photovoltaic power supply for the visitors center at Roxborough Park in Colorado is presented. The system will use Fresnel lenses with silicon solar cells and a bank of 110 lead-acid batteries of the locomotive type for storage. The power conditioning equipment and control system are described in detail, and installation and maintenance are discussed. (WHK)

11598 (DOE/CS/05315—1) **50 kWp Photovoltaic Concentrator Application Experiment, Phase I. Final report, 1 June 1978-28 February 1979.** Maget, H.J.R. (Varian Associates, Inc., Palo Alto, CA (USA)). 15 Jun 1979. Contract ET-78-C-04-5315. 268p. (CR—79-0318). Dep. NTIS, PC A12/MF A01.

This program consists of a design study and component development for an experimental 50-kWp photovoltaic concentrator system to supply power to the San Ramon substation of the Pacific Gas and Electric Company. The photovoltaic system is optimized to produce peaking power to relieve the air conditioning load on the PG & E system during summer afternoons; and would therefore displace oil-fired power generation capacity. No electrical storage is required. The experiment would use GaAs concentrator cells with point-focus fresnel lenses operating at 400X, in independent tracking arrays of 440 cells each, generating 3.8 kWp. Fourteen arrays, each 9 feet by 33 feet, are connected electrically in series to generate the 50 kWp. The high conversion efficiency possible with GaAs concentrator cells results in a projected annual average system efficiency (AC electric power output to sunlight input) of better than 15%. The capability of GaAs cells for high temperature operation made possible the design of a total energy option, whereby thermal power from selected arrays could be used to heat and cool the control center for the installation. System design and analysis, fabrication and installation, environmental assessment, and cost projections are described in detail. (WHK)

11599 (DOE/CS/40046—1(Vol.1)) **Trans-Pecos Photovoltaic Concentration Experiment. Final report for Phase-I system design, 6 June 1978-28 February 1979.** Marcy, W.M.; Dudek, R.A. (Texas Tech Univ., Lubbock (USA). Dept. of Systems). 30 Mar 1979. Contract ET-78-C-04-4269. 260p. Dep. NTIS, PC A12/MF A01.

The Trans-Pecos Photovoltaic Concentrating Experiment is the design of a 200 kWe peak photovoltaic concentrating system applied to deep well irrigation in the Trans-Pecos region of Texas. The site selected is typical of deep well irrigation in arid regions of Texas, New Mexico, and Arizona. The existing well utilizes a 200 horse power, three phase, 480 volt induction motor to lift water 540 feet to irrigate 380 acres. The Trans-Pecos Photovoltaic Concentration (PVC) system employs a two axis (azimuth-elevation) tracking parabolic concentrator module that focuses sunlight at 38X concentration on two strings of actively cooled silicon solar cells. The direct current from a field of 102 collector modules is converted by a maximum power point electric power conditioning system to three phase alternating current. The power from the power conditioning system is connected through appropriate switchgear in parallel with the utility grid to the well's induction motor. The operational philosophy of the experiment is to displace daytime utility power with solar generated electric power. The solar system is sized to provide approximately 50 percent of the 24 hour energy demand of the motor. This requires an energy exchange with the utility since peak solar power (200 kWe) generated exceeds the peak motor demand (149.2 kWe). The annual energy production is projected to be 511 Mwh using El Paso, Texas solar TMY data. System electrical power production efficiency is projected to be 7.4 percent at the design point, and 7.0 percent on an annual electrical energy production basis. The system is projected to provide 37.8 percent of the 24 hour energy demand of the motor at the design point of March 10, excluding energy delivered to the grid in excess of motor demand. The total energy produced is projected to be 39.0 percent of the 24 hour energy demand of the motor at the design point of March 10.

11600 (DOE/CS/94268—1) **RTI photovoltaic concentrator applications experiment. Phase I. System design. Final report, 1 June 1978-28 February 1979.** Burger, R.M.; Whisnant, R.A.; Drake, W.C.; Daluge, D.R.; Alberts, R.D. (Research Triangle Inst., Research Triangle Park, NC (USA)). Mar 1979. Contract ET-78-C-04-4268. 216p. (RTI—1638/00-1F). Dep. NTIS, PC A10/MF A01.

An experiment has been designed in which a 100 kW photovoltaic concentrator system serving the electrical load provided by an energy-efficient office-laboratory building will be built and operated in the Research Triangle Park of North Carolina. Since the purpose of the experiment is to provide the essential data for design and installation of future operational systems, the system is designed for operational flexibility. In its main operational mode, a defined primary load is diverted from the utility during all peak-demand periods. This requires the use of 1000 kWh of lead-acid batteries for energy storage. Other operational modes provide for obtaining data on peak demand reduction, on alternative battery use strategies, and on system performance with an isolated load. Operation of the system in parallel with utility-supplied power requires that the photovoltaic array outputs be inverted and that the power be controlled to achieve the operational objectives. Ten 2-axis tracking arrays consisting of 70X parabolic concentrators are used. The system will provide approximately 103 megawatt-hours of power annually to the load and the design is compatible with future retrofits including more efficient solar cells, higher concentration ratios, thermal energy collection, and other technological developments, ensuring its usefulness in research and development beyond the PRDA-35 experiment.

11601 (DOE/ET/23055—1) **Analysis and design of a 100-kilowatt solar photovoltaic flat-panel power system for a machining and metalworking facility in Columbus, Ohio. Phase I. Photovoltaic flat panel application experiment. Final report, October 1, 1978-February 28, 1979.** Noel, G.T.; Alexander, G.; Stember, L.H.; Stickford, G.H.; Broehl, J.H.; Carmichael, D.C. (Battelle Columbus Labs., OH (USA)). Mar 1979. Contract ET-78-C-04-5395. 163p. Dep. NTIS, PC A08/MF A01.

A 100-kW-peak flat-panel photovoltaic power system to supply power to a machine-shop load in Columbus, Ohio has been designed and analyzed by a Battelle-led team. The system will provide three-phase, 240-volt ac power to a Machining and Metalworking Facility which has 100 pieces of machinery and employs 50 machinists and other craftsmen. The system will operate in parallel with the utility which will supply backup power. Due to the close match of the array power output to the workday shop load, only a small amount of the power generated is excess to the concurrent

shop demand. When there is any excess, it will be fed to alternate loads at the site, rather than into the utility grid. The system performance analysis indicates that the system will supply approximately 115,000 kWh/year of electrical energy after all loses. The system uses high-energy-density flat-panel photovoltaic modules in a roof-mounted installation, and employs a microprocessor-controlled power conditioning unit. The overall system design, analysis of system performance and design alternatives, and detailed plans for installing, operating, and evaluating the system were developed in the project.

11602 (DOE/ET/23057—1(Vol.1)) **Photovoltaic flat panel system for process power in battery manufacture. Final report, September 30, 1978-March 31, 1979, Volume 1.** Sattolo, A.J.; Truncellito, N.T.; Schanzenbach, G.P. (Gilbert Associates, Inc., Reading, PA (USA)). 1979. Contract ET-78-C-04-5397. 157p. Dep. NTIS, PC A08/MF A01.

A flat panel solar photovoltaic system was designed to provide power to a production line in a newly-completed motorcycle battery manufacturing facility owned by the General Battery Corporation, located in Reading, Pennsylvania. The power will be used to form or change pasted battery grid plates prior to their encapsulation into battery cases. The load requirement is that 8100 amp hours of DC power be furnished to the plates over a period of about 18 hours. The array is large by present photovoltaic standards containing 1729 square meters of collectors and is capable of 195.4 kW peak output under 1 kW/m^2 of solar isolation. A modular approach is used in the buildup of the system. The array is built from Solarex HE354 GVM photovoltaic modules. These use Solarex's high efficiency, single crystal silicon cells mounted on Sunadex tempered glass. Each module contains diodes paralleled to every four cells to prevent internal damage in the event of a single cell shadowing. The modules are approximately .730 m^2 in area and contain 162 cells in three paralleled strings of 54 cells in series. The modules are connected in series of 10 to provide a voltage of 243 volts. They ae then paralleled in 24 sets to achieve 79.2 amps. The 240 modules make up the array portion of the Power Unit. A battery regulator in each Power Unit governs energy flow to and from the storage batteries. A power converter, also found in each Power Unit, transforms power input from the storage system or the array to the load.It is connected in parallel with the utility power supply. The storage system consists of 100 of General Battery's diesel locomotive starting batteries. These batteries can supply the full load for nearly two days. Each Power Unit has ten batteries connected in two parallel strings of 5 in series. Photovoltaic power system design, systems analysis, and component specification are presented. (WHK)

11603 (N—79-16036) **Satellite power systems (SPS) concept definition study. Volume 1. Executive summary. Final report.** Hanley, G. (Rockwell International Corp., Downey, CA (USA). Space Div.). Apr 1978. Contract NAS8-32475. 88p. NTIS, PC A05/MF A01.

The evolution of a total satellite power is described as well as major subsystem alternatives. Trade study results are given for satellite concepts, ground receiving antennas, satellite construction sites, and transportation. Point design definition, end-to-end analysis, and programmatics are covered. The GaAlAs photovoltaic concept is recommended as the current preliminary baseline satellite concept with silicon photovoltaic and Rankine cycle solar-thermal concepts as viable alternatives. Geosynchronous orbit is preferred for the construction of the satellite. A horizontal takeoff and landing air breathing rocket HLLV concept is preferred for earth-to-LEO transportation, with vertical takeoff options as viable alternatives. An argon electric orbit transfer vehicle is preferred for cargo transport frow LEO and GEO orbit, and a chemical LH_2/LO_2, two-stage orbit transfer vehicle is recommended for crew transport. A stripline rectenna array is the current preferred concept.

11604 (N—79-16037) **Satellite power systems (SPS) concept definition study. Volume 2. SPS system requirements. Final report.** Hanley, G. (Rockwell International Corp., Downey, CA (USA). Space Div.). Apr 1978. Contract NAS8-32475. 93p. NTIS, PC A05/MF A01.

Collected data reflected the level of definition resulting from the evaluation of a broad spectrum of SPS (satellite power systems) concepts. As the various concepts matured, these requirements were updated to reflect the requirements identified for the projected satellite system/subsystem point design(s). The study established several candidate concepts which were presented to provide a basis for the selection of one or two approaches that would be given a more comprehensive examination. The two selected concepts were expanded and constitute the selected system point designs. The identified system/subsystem requirements was emphasized and information on the selected point design was provided.

11605 (N—79-16039) **Solar power satellite rectenna design study: directional receiving elements and parallel-series combining analysis. Final report, 3 February 1978-1 December 1978.** Gutmann, R.J.; Borrego, J.M. (Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Electrical and Systems Engineering). Dec 1978. Contract NAS9-15453. 123p. NTIS, PC A06/MF A01.

Rectenna conversion efficiencies (RF to dc) approximating 85 percent were demonstrated on a small scale, clearly indicating the feasibility and potential of efficiency of microwave power to dc. The overall cost estimates of the solar power satellite indicate that the baseline rectenna subsystem will be between 25 to 40 percent of the system cost. The directional receiving elements and element extensions were studied, along with power combining evaluation and evaluation extensions.

11606 **Energy analysis of the solar power satellite.** Herendeen, R.A.; Kary, T.; Rebitzer, J. (Univ. of Illinois, Urbana). *Science;* **205**: No. 4405, 451-454(3 Aug 1979).

The energy requirements to build and operate the proposed Solar Power Satellite are evaluated and compared with the energy it produces. Because the technology is so speculative, uncertainty is explicitly accounted for. For a proposed 10-gigawatt satellite system, the energy ratio, defined as the electrical energy produced divided by the primary nonrenewable energy required over the lifetime of the system, is of order 2, where a ratio of 1 indicates the energy breakeven point. This is significantly below the energy ratio of today's electricity technologies such as light-water nuclear or coal-fired electric plants.

11607 (SAND—79-1873C) **SOLSTOR results for a photovoltaic/battery system with time-of-day pricing and sellback.** Caskey, B.C.; Caskey, D.L.; Aronson, E.A. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 5p. (CONF-800101—2). Dep. NTIS, PC A02/MF A01.

From Systems simulation and economics analysis conference; San Diego, CA, USA (23 Jan 1980).

The Sandia Laboratories' optimizing computer code, SOLSTOR, has been utilized to investigate the role of battery storage in a residential flat plate photovoltaic (PV) system. The system is connected to the utility grid and time-of-day pricing and sellback policies are considered. The study assumes that the 1986 PV module cost goals will be met, and hence PV systems will be competitive with grid electricity. A range of battery costs is included. Systems installed in three cities (Phoenix, AZ, New York, NY, and Columbia, MO) were optimized based on minimizing the 20 year life cycle energy cost for a typical all-electric single family dwelling. The results show that the usefulness of batteries is a strong function of the battery costs, economic conditions, time-of-day pricing ratio, and the sellback ratio. At about $100/kWh, batteries can generally lower life cycle costs. Also, the synergism of PV arrays and batteries can result in larger PV arrays for the optimized system. In particular, it was determined that whenever either the sellback ratio was 0.5 or less, or the peak/off-peak electric rate ratio was greater than 3:1, batteries were an economic asset in the system.

11608 (SAND—80-0076C) **Protection of terrestrial photovoltaic systems from lightning effects.** Rogers, C.B. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 6p. (CONF-800106—6). Dep. NTIS, PC A02/MF A01.

From 14. photovoltaics specialists conference; San Diego, CA, USA (7 Jan 1980).

Transients caused by nearby strokes constitute the major threat from lightning to photovoltaic power systems. Failure thresholds of silicon solar cells are dominated by the melting of the metal grid on the illuminated face of the cell. The optical flash from lightning is not a significant threat to cells. The use of guard wires over underground cables appears to be a cost-effective shielding technique. Terminal protection devices are available although their use may require some special design features.

11609 (SAND—80-0141C) **Photovoltaic system cost experience for intermediate-sized applications.** Burgess, E.L. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 14p. (CONF-800106—10). Dep. NTIS, PC A02/MF A01.

From 14. photovoltaics specialists conference; San Diego, CA, USA (7 Jan 1980).

This paper gives the prices for all system elements of nine experimental intermediate-sized photovoltaic systems which are presently being constructed. The balance-of-system pricing terminology adopted by the National Photovoltaic Program is used to categorize the system price elements. At this time the prices are estimates developed from preliminary and/or detailed system designs.

11610 (SAND—80-0142C) **Low cost structures for photovoltaic arrays.** Post, H.N. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 6p. (CONF-800106—9). Dep. NTIS, PC A02/MF A01.

From 14. photovoltaics specialists conference; San Diego, CA, USA (7 Jan 1980).

The design and analysis of low cost, ground-mounted flat plate non-tracking array structures for use in large intermediate and central power station applications are described. Design require-

ments for the array structure, especially wind loading criteria, are discussed and problem areas associated with the integration of the module panel and support structure are identified. Support system costs which include site preparation, foundation and support structure, and installation costs are summarized. Wind effects data derived from comprehensive wind tunnel tests of flat plate array field models are presented and compared with wind loading estimates based on existing design standards.

11611 (SAND—80-0144C) **Photovoltaic intermediate applications.** Biringer, K.L. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 5p. (CONF-800106—8). Dep. NTIS, PC A02/MF A01.

From 14. photovoltaics specialists conference; San Diego, CA, USA (7 Jan 1980).

Intermediate applications for on site photovoltaic systems range in size from ~ 20 kW to well over 1 MW and cover a variety of users including commercial, industrial, agricultural, multi-family residential, municipal, and others. This paper discusses results of recent studies in each of these sectors. Characteristics of the load profiles and economic parameters for different users are described along with energy consumption data for the different applications. Preliminary assessments of favorable photovoltaic applications and their economic viability are made and preferred system configurations discussed. Other features of intermediate applications and loads which impact photovoltaic designs are highlighted.

11612 20 kW gallium arsenide photovoltaic Dense Array for central receiver concentrator applications. Cape, J.A.; Sahai, R.; Harris, J.S. (Rockwell International Science Center, Thousand Oaks, CA). pp 1027-1034 of 2nd E.C. photovoltic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The objective of this project is to explore the feasibility of operating photovoltaic subsystems on a central receiver tower on which is focused highly concentrated (up to 1500 SUNs) sunlight by a large field of mirrors. Essential to the design of the photovoltaic subsystem, which is called a Dense Array, is achieving nearly 100% active area utilization of the incident solar flux. This is done in the present concept by overlapping a series of solar cell modules, rather like shingles, so that the current collection strips and interconnects, coolant lines, and other non-active elements are shaded from the insolation. The array which will produce 20 kW presents a frontal area of 0.13 M^2 and consists of four panels, electrically in parallel. Each panel consists of 16 modules of 16 GaAs cells each, connected in series. This will result in a system output of ~ 240 volts and 80-85 Amps at 1000 SUNs AM1. The design goal is to achieve greater than 16% over-all conversion efficiency, including area losses. The Dense Array will be tested at the Sandia Laboratories Solar Thermal Test Facility. A wide temperature range (25° to 180°C) and concentration range (500 to 1500 SUNs) will be explored to gain information of potential relevance to combined thermal electric applications.

11613 A 1 kW photovoltaic demonstration project. Hedstroem, J.; Kaellbaeck, B.; Sigurd, D.; Weissglas, P. (Inst. of Microwave Tech., Stockholm, Sweden). pp 1036-1037 of 2nd E.C. photovoltic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The 1 kW photovoltaic test facility in Sweden, which will be operative in May 1979, is briefly described. (WHK)

11614 New approach to solar pump systems using submersible motors. Franx, C. (N.V. Philips Gloeilampenfabrieken, Eindhoven, Netherlands). pp 1038-1045 of 2nd E.C. photovoltic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The new pump system consists of 48 Solar Modules BPX 47A feeding a standard three phase ac submersible pump via a newly developed dc-ac convertor. This convertor also provides an optimum power match between solar panels and the submersible pump under varying conditions of power supply (low or high sun) or power demand (low or high water level in the well). The power match is controlled by varying the frequency, which is on its turn enabled by application of the pulse width modulation principle. The system efficiency compares very well with the value deducted from laboratory measurements.

11615 Calculations and experimental data of water pumping systems with respect to photovoltaic converter arrays. Hanitsch, R. (Technical Univ., Berlin, Germany). pp 1046-1053 of 2nd E.C. photovoltic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

This paper is intended to provide a review of the current status and the trends in the development of efficient water pumping systems done at the Institute for Electrical Machines at the Technical University, Berlin (FRG). Various water pumping solar systems are pursued: (a) brushless d.c. machine with electronic commutation, (b) asynchronous machine with dc/ac converter; and (c) conventional d.c.-machine with a combined excitation in order to increase the starting torque. Considerable development and engineering efforts are still required for some of the components of the water pumping system to meet the long-range cost goals.

11616 Engineering studies on the optimization of the collection subsystem of a 1 MW photovoltaic facility. Selles, L.; Euvrard, A. (Seri Renault Engineering, Bois D'Arcy, France). pp 1054-1064 of 2nd E.C. photovoltic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

In view of investigating the possibilities for a large scale use of photovoltaic (PV) electricity in the early Eighties, Seri Renault Engineering has evaluated a number of alternatives for the conceptual design of an intermediate size power plant (500 kW to 1 MW). This engineering evaluation assessed the best solutions for the sunlight collection subsystem. The three key alternatives - the PV materials, the orientation modes, the sunlight concentration - are investigated through a global approach, as well as at the level of the various components involved. It is shown that the optimizations cannot be carried out without considering the types and the profiles of the demand. For each alternative a parametric analysis is performed in a view of comparisons made in terms of investment and operating costs.

11617 Influence of meteorological conditions on the design of solar energy dc-ac inverters. Baert, D.; De Vos, A.; Van Hoogenbemt, G. (Rijksuniversiteit, Gent, Belgium). pp 1065-1073 of 2nd E.C. photovoltic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A practical way to use the power generated by photovoltaic cells is to convert the dc output of the cells into ac. This can be done by means of a mains commutater inverter, e.g., a phase controlled rectifier. Since the cost of the inverter depends on the range of powers to be inverted, the question arises if it is worthwhile to design it for the total power range from zero to peak power of the solar cell panel. The amount of energy lost by limiting the power transfer at both extremes of the range, depends on the meteorological conditions of the site and can be calculated. A computer program has been set up to simulate the output of such an inverter, fed by a solar panel of fixed (but arbitrary) orientation. Typically, in Belgium, if the inverter of a 5 kW peak power solar cell panel is limited to 675 kW minimum and 3.2 kW maximum, then only 10% of the yearly photovoltaic energy is sacrificed. It follows that the cost of the phase controlled rectifier is thereby reduced by about 40%. For tropical sites similar results are obtained. This work is a first step in the design of a real economically justified small system inverter.

11618 Sophia Antipolis 5 kW photovoltaic power generator for habitat. Denis, D.J. pp 1074-1080 of 2nd E.C. photovoltic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A 5 kW photovoltaic cell system that features several modes of solar energy collection, electricity storage in a 150 kWh accumulator and a specially tailored dc/ac converter is described. The objectives of this effort are to supply electricity to the tenant of a house just as the utility grid would do and to allow experimentation and selection of best suitable concepts and materials on a full size installation. The 5 kW solar cell power system is being installed at Sophia Antipolis near Nice on the French Riviera and is due to start functioning in early 1980.

11619 New energies in telecommunications: AEROSOLEC Station. Maumus, J.P. (CNET, Paris, France). pp 1081-1086 of 2nd E.C. photovoltic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The principle of the power plant AEROSOLEC designed for powering remote microwave relay stations is discussed. Changes brought about in the pilot station at La Turbie during the past year, together with weekly outputs delivered by the solar and wind generators from June 1977 to July 1978 are provided - the yields reveal a complementarity of solar and aeolian energies intime in favor of the reduction in capacity of the storage batteries. For the year under consideration, the price of the solar and aeolian kWh

respectively is provided, characterizing for the given period the La Turbie site by its solar and aeolian lodes. A brief description is provided of other plants of the aerosolec type for which the dimensioning has been assessed on the basis of results obtained at the La Turbie pilot station.

11620 Operational characteristics of a 60 kW photovoltaic system integrated with a utility grid. Suelzle, L.R. (Delta Electronic Control Corp., Irvine, CA); Roesler, D.J. pp 1096-1103 of 2nd E.C. photovoltic solar energy conference. Van Overstraeten, R.J.; Palz, E. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Under the sponsorship of the US Department of Energy, Delta Electronic Control Corporation (DECC) has designed and built a 60 kW photovoltaic power system. The power system will operate from a 60 kW array without energy storage and will produce low-distortion, 480/277 Vac, 60 Hz output to augment a remote utility grid. The program has been initiated and administered by the US Army Mobility Equipment Research and Development Command, Fort Belvoir, Virginia. Tests have been performed on the power conversion system at full power from an array simulator and at 30 kW from the photovoltaic array at the DECC facility. The system has met or exceeded all major specification requirements and has operated, without problems, augmenting the utility grid at DECC since December 1978. The automatic start-up and shut-down controls incorporated into the system have allowed the system to operate unattended. The system is being installed at a remote California military site where it will augment an existing diesel-powered utility grid and provide an average of 10% of the grid power. The operating characteristics of the system are described.

11621 Revised economic analysis of photovoltaic power modules. Whale, A.V.; Wingrove, R.D. (Ferranti Electronics Ltd., Oldham, England). pp 251-259 of 2nd E.C. photovolatic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; R. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The success of photovoltaic power generation as a viable and economic source of electricity for the future, depends largely on a significant cost reduction of the basic building unit, the photovoltaic module. The target price set by the American Department of Energy is US $0.50 by 1985, and was based on long ranging assumptions on silicon prices and the development of sophisticated and fully automated production machinery. A method of cost analysis is presented which indicates that this level of cost reduction may not in fact be achievable by 1985, (if ever), in view of the fact that the product, although partly related to semiconductor techniques and processes, is ultimately one in which mechanical engineering aspects become predominant, and that the costs, once silicon has been reduced to a much lower level, are limited by module frame materials costs and various overheads, and that this lower limit is more likely to be around the $3 to $4 level than the $1.30 predicted ($1.30 corresponds to 10 years inflation at 10% on $0.50). An equation is presented that allows full analysis of the individual costs that make up the complete module cost.

11622 Photovoltaic power generators in space. Reinhartz, K.K. (European Space Research and Technology Centre, Noordwijk, Netherlands). pp 456-468 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

For almost twenty years solar generators for spacecraft were the main application of photovoltaic energy conversion. A review of the requirements, the technology status and development trends of space solar cell generators is given. Its major aim is to give those photovoltaic specialists who are not familiar with space activities a summary description of the experience in photovoltaic energy conversion which was and still is being developed in the space programs. In addition, possible future trends for photovoltaic power generation in space are shortly discussed including the Satellite Power System as a potential solar energy conversion system for terrestrial use.

11623 Requirements for future Air Force satellite solar power technology. Wise, J.F. (Aero Propulsion Lab., Wright-Patterson AFB, OH). pp 469-476 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Recent studies have indicated that Air Force satellite power levels and reliability requirements will increase in the next decades. New methods for launching these satellites through the use of the Space Shuttle and such intermediate vehicles as the Inertial Upper Stage are also under development. This paper discusses the solar power technology development underway within the US Air Force to meet these challenges. The near term capability of silicon solar cells in the 14 to 16% efficiency range is discussed, and the potential and payoff of the GaAs solar cells are indicated. The high risk challenges of the multibandgap solar cell developments are also discussed leading to efficiency in the 25 to 35% range. Technology in improved power system regulation and control is also required to meet the mission scenarios of the next few decades. It is shown that present power system capabilities in synchronous orbit are under 5 kW and with the application of the GaAs solar cell and nickel hydrogen battery technology currently demonstrated in laboratory cells, a power level in the 8 kW range is attainable. To reach beyond the 10 kW level, using presently identified launch capabilities, the developments of more efficient power control systems, improved energy storage, and multibandgap solar cells are urgently required.

11624 Development of 1pKW photovoltaic module with concentration. Pizzini, S. (Istituto Donegani, Montedison Novara, Italy); Giuffrida, M.; Zani, P.; Scarpi, G.; Dionisio, G.; Conti, M.; Modelli, A. pp 532-540 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The Italian companies Montedison, Ansaldo, Officine Galileo and SGS-Ates have jointly designed and developed with EEC and CNR financing, a 1pKW concentration photovoltaic array with silicon cells, afocal lenses and passive cooling. The concentrator consists of a mounting frame, whose tracking mode is alt-azimuthal and ten individual modules. The selected concentration ratio is 50. The afocal lenses provide an optimum flux distribution on the plane of the cell, reduce the incidence of chromatic aberration, and tolerate partial shadowing without affecting the illumination profile. The cells, developed by SGS-Ates, have an n/p^+ structure, a Ti-Pd-Ag front metallization pattern, an Al-Cr-Ni-Au back metallization and a silicon nitride AR layer. They display efficiencies in excess over 16%. The tracking system consists of two independent motors for the zenithal and azimuthal movements which are driven by two control units: the azimuthal movement has a constant speed basis plus a superimposed increment derived by the sun sensor. The zenithal movement is completely controlled, via a suitable operational amplifier and a comparator, by the sun sensor.

11625 Integration of photovoltaic generation into a large generating system. Manzoni, G.C. (ENEL, Milan, Italy); Taschini, A.; Salvaderi, L. pp 552-562 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

The decision of making use of photovoltaic conversion in an electric system that already exists, or has to be planned, requires an estimate of the value to be placed on the energy obtained by this new source, and an examination on any possible changes that should be made in the generation mix of the electric system. This is the first step of the cost-credit comparison necessary to justify a new way of generating electric energy. A general methodology is described that can be used for the economic evaluation of energy sources highly depending on astronomical and meteorological events, such as solar generation, in the case of plants of medium-to-high power, connected to the electric subtransmission or transmission grid. Finally examples of application of this approach to electric systems of the European-type are discussed.

11626 Analysis, design, and realization of a 5 kW photovoltaic generator. Keaveny, D.; Kruse, C. (AEG Telefunken, Wedel, Germany). pp 584-592 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A 5 kW photovoltaic power supply system is described. The power supplied is used to drive a vhf transmitter. This solar generator consists of 486 modules, composed of square shaped solar cells. The complete power supply also includes a storage battery and a self contained monitoring system. Berlin was chosen as the site for the installation. Since the end of November 1978 a small monitoring unit has been in operation for direct on-site measurements.

11627 Design and construction of a 100 kW photovoltaic remote stand-alone power system. Lyon, E.F. (Massachusetts Inst. of Tech., Lexington). pp 593-600 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

A 100 kW peak photovoltaic (PV) power system is now under construction in a remote national park in southeastern Utah. Sponsored jointly by the United States Department of Energy and

the National Park Service, the system will include the largest flat-plate array field in the world. Over 266,000 N on P silicon PV cells will be contained in the glass-covered array modules. Energy from the array will be supplied to site loads as ac power or stored in a large lead-calcium battery. Although most buildings at this remote community use LP gas for heating, the PV system will supply all heating and cooling requirements for a central PV building from solar PV power. The park, with its diversified mix of loads and its lack of public utility power, is typical of tens of thousands of remote settlements in the world which presently rely on diesel-powered generators for electric power. Upon completion of the PV system late in 1979, the present diesel will be relegated to a backup role and is expected to supply less than 15% of the annual electrical consumption at the site.

11628 Study of a hydro-photovoltaic plant for peak power generation in central and northern European countries. Smekens, G.R.; Carbonelle, G.; Gaasch, R.A. (S.A. Energies Nouvelles et Environnement, Brussels, Belgium). pp 601-609 of 2nd E.C. photovoltaic solar energy conference. Van Overstraeten, R.J.; Palz, W. (eds.). Hingham, MA; D. Reidel Publishing Co. (1979).

From 1979 photovaltaic solar energy conference; West Berlin, F.R. Germany (23 Apr 1979).

Hydraulic energy, as well as solar energy varies seasonally very strongly in central and northern Europe. In non alpine type rivers however, months of peak hydraulic energy occur during months of minimum solar energy. The sum of both such energies varies seasonally far less and has a seasonally constant component which can reach 70% of the yearly average. The study demonstrates on the basis of existing hydraulic and solar data at a given site in Luxemburg that the daily sum of the two random energies yields a total which has a far higher degree of reliability than that of the separate components. It is shown that, given a small storage system, a combined hydro-electric and photovoltaic power plant is a prime candidate in northern-central Europe as an alternative to conventional gas turbine or pumping generating plants given their functions as peak power production units. The requirements on reliability are taken at the same level of performance as those of similar systems connected to the grid. An economic assessment of the combination is made on the basis of a model characterizing both sources of energy. The study indicates that a hydro-photovoltaic combination is to be optimized at the plant design phase as well as during daily operation. The study shows which are the key parameters for optimum technical and economic performance of a hydro-photovoltaic generating unit and in demonstrating the substantial reduction in the random nature of the hydro-photovoltaic combination, the study establishes a means of using photovoltaic energy as a viable alternate for generating power on the grid.

11629 Mississippi County Community College: a photovoltaic demonstration project. Woodsmall, W.M. Jr. (Cromwell, Neyland, Truemper, Levy & Gatchell, Inc., Little Rock, AR). pp 128-135 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

An overall view of the integration of all systems involved in the world's largest photovoltaic demonstration project is given. Mississippi County Community College in Blytheville is presently being planned using a 240 kW +- photovoltaic collection field for its energy source. Systems include the collectors, thermal, process control, storage (both thermal and electrical) power conditioning, and the building itself.

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 11583, 11603, 11604, 11605, 11689

11630 (ATR—79(7780)-1) **Solar Thermal Small Power Systems Study. Inventory of US industrial small electric power generating systems.** (Aerospace Corp., Los Angeles, CA (USA). Energy and Resources Div.). 1 Jun 1979. Contract ET-78-C-03-2226. 59p. Dep. NTIS, PC A04/MF A01.

This inventory of small industrial electric generating systems was assembled by The Aerospace Corporation to provide a data base for analyses being conducted to estimate the potential for displacement of these fossil-fueled systems by solar thermal electric systems no larger than 10 MW in rated capacity. The approximately 2100 megawatts generating capacity of systems in this category constitutes a potential market for small solar thermal and other solar electric power systems. The sources of data for this inventory were the (former) Federal Power Commission (FPC) Form 4 Industrial Ledger and Form 12-C Ledger for 1976. Table 1 alphabetically lists generating systems located at industrial plants and at Federal government installations in each of the 50 states. These systems are differentiated by type of power plant: steam turbine, diesel generator, or gas turbine. Each listing is designated as a power system rather than a power unit because the FPC Ledgers do not provide a means of determining whether more than one unit is associated with each industrial installation. Hence, the user should consider each listing to be a system capacity rating wherein the system may consist of one or more generating units with less than 10 MW/sub e/ combined rating. (WHK)

CENTRAL RECEIVER

REFER ALSO TO CITATION(S) 11428

11631 (CONF-781108—, pp 209-228) **Stochastic mirror errors: computation of optical concentration distributions and variance distributions on solar receiver/boilers.** Reichert, J.D. (Texas Tech Univ., Lubbock). Jul 1979.

From 4. DOE statistical symposium; Albuquerque, NM, USA (1 Nov 1978).

A general procedure for the computation of first and second moments of optical concentration profiles is presented and illustrated. The procedures do not involve ray tracing methods and are capable of producing great accuracy with reasonable computation times. Typical results are shown for conical boilers suspended in spherical segment mirrors such as those employed in the DOE Crosbyton Solar Gridiron Concept.

11632 (DOE/ET/20424—4) **Central Receiver Solar Thermal Power System. Hailstone simulation test report.** (Boeing Engineering and Construction Co., Seattle, WA (USA)). 15 Feb 1978. Contract EY-76-C-03-1111. 17p. Dep. NTIS, PC A02/MF A01.

The purpose of the work described is to verify heliostat survival and evaluate material damage resultant from the impact of 1 inch hailstones traveling at terminal velocity (75 feet/second). Data obtained from the tests were also used to predict the loss in specular transmittance of the plastic heliostat enclosures due to hail damage possible at potential solar thermal power plant sites in southwestern United States. The approach taken was to subject several different typical enclosure materials as well as an existing enclosure at Boardman, Oregon, to hailstone bombardment and measure and analyze the effects on enclosure performance. Hailstorm frequency and severity data, although sparse and highly generalized, was found in the literature and used along with the experimental data to predict total accumulative damage after 15 years of exposure. (WHK)

11633 (LBL—9321) **Sensible heat storage for a solar thermal power plant.** Baldwin, T.F.; Lynn, S.; Foss, A.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1979. Contract W-7405-ENG-48. 195p. Dep. NTIS, PC A09/MF A01.

Thesis.

This report examines one possible configuration for a solar power plant with a sensible-heat storage unit. The proposed flowsheet allows thermal energy storage between the heat collection unit and the power generation unit without a reduction in the thermodynamic availability of the energy suppled to the power turbines. Energy is stored by heating a checkerwork of magnesia bricks. A gas that is circulated from the solar collector through the storage unit and the power plant boiler serves as the heat-transfer medium. Nitrogen was found to be preferable to helium for this purpose. A computer model was used to predict the behavior of the sensible-heat storage unit and to aid in sizing the storage unit. Procedures were developed to estimate the cost of electricity generated by the solar power plant. These procedures illustrate the effects of changes in the energy storage unit on the cost of electricity. The effects on the storage unit and on the total plant design of changing several process and design parameters were then evaluated. This study has led to the design of two alternative process configurations for solar power plants with sensible-heat storage. The sensible-heat storage process was also compared to the sulfur oxide chemical-heat storage process. The proposed configuration for a solar power plant with sensible-heat storage for nighttime electricity generation produces electricity at the cost of $87 per MW/sub e/-hr.Both of these power plants convert 32% of the energy absorbed by their solar collectors into usable electric energy. It is concluded that sensible-heat storage can provide energy storage for a solar power plant at a reasonable price using technology that is presently available.

11634 (PNL-SA—7200) **Heliostat glass survey and evaluation.** Lind, M.A.; Russin, J.M. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1978. Contract EY-76-C-06-1830. 32p. Dep. NTIS, PC A03/MF A01.

The glass characterization and specification task included a comprehensive survey of both foreign and domestic sources of low distortion, low iron, .125 nominal flat glass for use in heliostat applications. PNL attempted to determine the availability of production lines, estimate industry interest, lead times, and costs for producing glass for second surface heliostat mirrors for the Barstow pilot plant and future commercial plants. Glass samples representative of the industry production capability were collected and characterized.

The results of the survey and analysis were used to generate a specification for the Barstow Pilot Plant glass procurement.

11635 (PNL-SA—7637) **Weathering and leaching of glass for solar heliostats.** Rusin, J.M. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1979. Contract EY-76-C-06-1830. 27p. Dep. NTIS, PC A03/MF A01.

In order to assess the effects of weathering on the transmittance of glass, several old samples were collected from two desert environments for evaluation. The glass obtained by PNL at the Hanford reservation in Washington came from south-facing, vertical windows which were known to be over forty years old. The glass obtained by Sandia from Barstow, California, is estimated to be over twenty years old. To determine the durability of glasses proposed for heliostat mirrors, selected samples were leached in a Soxhlet apparatus and pH 4 and pH 9 buffer solutions. The glass samples produced by the float process are soda-lime-silica glasses, whereas the glass samples produced by the fusion process are aluminosilicate glasses. Results are presented and discussed. (WHK)

11636 (SAN—1726-1(Vol.3)) **Closed Brayton cycle advanced central receiver solar-electric power system. Volume III. Development plan for a commercial-scale closed Brayton cycle Advanced Central Receiver Power Plant with coupled sensible heat storage. Final report.** Halvorson, K.W. (Boeing Engineering and Construction Co., Seattle, WA (USA)). Nov 1978. Contract EG-77-C-03-1726. 95p. Dep. NTIS, PC A05/MF A01.

A development plan is presented to advance the closed Brayton cycle, storage-coupled, Advanced Central Receiver Power Plant conceptual design to an initial commercial-scale operational plant in 1985. The plan describes the development approach utilized, the major program elements in the development path, and the technology items which must be improved and/or verified. The plan covers three sequential program phases. Phase II provides for technology development by Subsystem Research Experiments, analyses and test; the preliminary design of the initial 50 MW/sub e/ plant; and refinements to the Phase I conceptual design, costs, and schedules. Phase III provides the design phase for the 50 MW/sub e/ plant and the necessary permits and certifications. Construction, checkout, and operation of the 50 MW/sub e/ plant, and detailed design of the preferred 150 MW/sub e/ plant will occupy Phase IV. Program schedules and costs are estimated for the development phases.

DISTRIBUTED COLLECTOR

11637 (N—79-20492) **Thermal power systems point-focusing distributed receiver technology project. volume 1: executive summary. Annual report.** Lucas, J. (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Feb 1979. Contract NAS7-100. 31p. NTIS, PC A03/MF A01.

Thermal or electrical power from the sun's radiated energy through point-focusing distributed receiver technology is the goal of this project. The energy thus produced must be technically, as well as economically, competitive with other energy sources. This project is to support the industrial development of the required technology to achieve the above stated goal. Solar energy is concentrated by either a reflecting surface or a lens to a receiver where it is transferred to a working liquid or gas. Receiver temperatures are in the 1000 - 2000 F range. Conceptual design studies are expected to identify power conversion units with a viable place in the solar energy future. Rankine and Brayton cycle engines are under investigation. This report details the Jet Propulsion Laboratory's accomplishments with point-focusing technology in Fy 1978.

TOTAL ENERGY AND HYBRID SYSTEMS

11638 (ALO—4231-09(Vol.1)) **Fort Hood Solar Total Energy Project. Volume I. Executive summary. Final report.** (American Technological Univ., Killeen, TX). Jan 1979. Contract EM-78-C-04-4231. 47p. Dep. NTIS, PC A03/MF A01.

A summary of the history, design, performance, supporting activities, and management plans for the Solar Total Energy System for the troop housing complex at Fort Hood, Texas, is presented. (WHK)

11639 (ALO—4231-09(Vol.3)) **Fort Hood Solar Total Energy Project. Volume III. Engineering drawings. Final report.** (American Technological Univ., Killeen, TX). Jan 1979. Contract EM-78-C-04-4231. 52p. Dep. NTIS, PC A04/MF A01.

Engineering drawings are presented for the Solar Total Energy System at Fort Hood, Texas. Drawings are given for the solar collector subsystem, power conversion subsystem, instrumentation and control subsystem, thermal storage subsystem, site preparation, thermal storage area piping and equipment layout, heating/cooling and domestic hot water subsystem, STES building and facility, and electrical distribution. (WHK)

11640 (ALO—4231-09(Vol.4)) **Fort Hood Solar Total Energy Project. Volume IV. Project Management Plan. Final report.** (American Technological Univ., Killeen, TX). Jan 1979. Contract EM-78-C-04-4231. 83p. Dep. NTIS, PC A05/MF A01.

The Project Management Plan presented is designed to implement the definitive design phase of this project by establishing the organization, tasks, schedules, and controls to assure the accomplishment of project objectives within time and budgetary constraints. Specifically, the plan presents a functional organization composed of a team of personnel with proven experience and capability; clear and concise methods for evaluation and control of project activities and costs; and a set of procedures that provides a means for sound and timely decisions and actions relative to project tasks and milestones. Since a significant portion of the overall design effort is to be performed by a subcontractor, Westinghouse Electric Corporation, this management plan, in conjunction with subcontract provisions, establishes a sound base for evaluation, control and coordination of all activities associated with their respective tasks. (WHK)

11641 (ALO—4271-01) **Fort Hood solar total energy project. Technical support and systems integration. First semiannual report, May 1-October 31, 1978.** (Aerospace Corp., El Segundo, CA (USA). Energy and Resources Div.). 1978. Contract ET-78-C-04-4271. 119p. (ATR—79(7743)-1). Dep. NTIS, PC A06/MF A01.

Progress on the design of a Solar Total Energy System which will supply a significant portion of the energy requirements of a troop housing complex at Fort Hood, Texas, is described. Selection and sizing of the distributed collector field are discussed, and parabolic trough collector technology is reviewed. Energy load measurements and insolation models for the Fort Hood site are described. Technical project support efforts are reviewed. (WHK)

11642 (DOE/CS/8720—4) **Southwest Project: resource/institutional requirements analysis. Volume IV. Institutional studies.** (Arizona Power Authority, Phoenix (USA); Arizona Public Service Co., Phoenix (USA); El Paso Electric Co., TX (USA); Nevada Power Co., Las Vegas (USA); Stone and Webster Engineering Corp., Boston, MA (USA)). Dec 1979. Contract EM-76-C-01-8720. 182p. Dep. NTIS, PC A09/MF A01.

The purpose of this study was to investigate ways to accelerate the commercialization of solar electric-generating plants and their expected market penetration into the electric utility network of the southwestern US through year 2000. The study was conducted primarily from a utility perspective and included the utility view of the technical, legal, economic, and institutional considerations necessary to make central-station generation of electricity from solar power commercially successful. No dispersed uses of solar electric generation were addressed. The report provides a basis from which periodic updates can be made to analyze the effect of economic trends and technology developments on utilization of solar and/or conventional electric generation as technology continues to progress in future years. The basis established in this report utilized current state-of-the-art technology for solar and conventional electric generating plants. Also, 1977 costs of conventional electric generating plants were utilized. The cost of first generation commercial solar electric generating plants was based on assumptions reflecting large-scale manufacturing of components by a mature industry.

11643 (ALO—4231-09(Vol.2)(Pt.1)) **Fort Hood Solar Total Energy Project. Volume II. Preliminary design. Part 1. System criteria and design description. Final report.** (American Technological Univ., Killeen, TX). Jan 1979. Contract EM-78-C-04-4231. 499p. Dep. NTIS, PC A21/MF A01.

This volume documents the preliminary design developed for the Solar Total Energy System to be installed at Fort Hood, Texas. Current system, subsystem, and component designs are described and additional studies which support selection among significant design alternatives are presented. Overall system requirements which form the system design basis are presented. These include program objectives; performance and output load requirements; industrial, statutory, and regulatory standards; and site interface requirements. Material in this section will continue to be issued separately in the Systems Requirements Document and maintained current through revision throughout future phases of the project. Overall system design and detailed subsystem design descriptions are provided. Consideration of operation and maintenance is reflected in discussion of each subsystem design as well as in an integrated overall discussion. Included are the solar collector subsystem; the thermal storage subsystem, the power conversion sybsystem (including electrical generation and distribution); the heating/cooling and domestic hot water subsystems; overall instrumentation and control; and the STES building and physical plant. The design of several subsystems has progressed beyond the preliminary stage; descriptions for such subsystems are therefore provided in more detail than others to provide complete documentation of the work performed. In some cases, preliminary design parameters require specific verificaton in the definitive design phase and are identified in the text. Subsystem descriptions will continue to be issued and revised separately to maintain accuracy during future phases of the project. (WHK)

11644 (ALO—4231-09(Vol.2)(Pt.2)) **Fort Hood Solar Total Energy Project. Volume II. Preliminary design. Part 2. System performance and supporting studies. Final report.** (American Technological Univ., Killeen, TX). Jan 1979. Contract EM-78-C-04-4231. 479p. Dep. NTIS, PC A21/MF A01.

The preliminary design developed for the Solar Total Energy System to be installed at Fort Hood, Texas, is presented. System performance analysis and evaluation are described. Feedback of completed performance analyses on current system design and operating philosophy is discussed. The basic computer simulation techniques and assumptions are described and the resulting energy displacement analysis is presented. Supporting technical studies are presented. These include health and safety and reliability assessments; solar collector component evaluation; weather analysis; and a review of selected trade studies which address significant design alternatives. Additional supporting studies which are generally specific to the installation site are reported. These include solar availability analysis; energy load measurements; environmental impact assessment; life cycle cost and economic analysis; heat transfer fluid testing; meteorological/solar station planning; and information dissemination. (WHK)

OCEAN THERMAL GRADIENT POWER PLANTS

11645 (COO—4683-4) **Results of a near field physical model study.** Adams, E.E.; Fry, D.J.; Coxe, D.H. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Civil Engineering). 1979. Contract ET-78-S-02-4683. 8p. (CONF-790631—19). Dep. NTIS, PC A02/MF A01.

From 6. OTEC conference; Washington, DC, USA (19 Jun 1979).

A physical model study is ongoing to investigate the sensitivity of recirculation and near field plume dynamics to variation in OTEC plant design and ambient ocean conditions. A thermally-stratified 18 x 12 x 0.6 m basin at a nominal scale of 1/300 allows the upper 180 m of the ocean to be studied for plant sizes up to 600 MW(e). Tests have been conducted for stagnant conditions and for conditions with a current, using both the mixed discharge (combined evaporator and condenser) and non-mixed discharge concepts. Separate tests were made to investigate interactions between evaporator and condenser discharges in a non-mixed concept. Measurements include temperature, dye concentration, mean velocity and visual observations obtained from still and motion pictures. Results for the stagnant water tests showed no significant recirculation except for those tests where the discharge ports were oriented (slightly) upward or where the largest plant size (600 MW(e)) was tested. No significant difference in recirculation could be discerned between the mixed and the non-mixed discharge designs although differences in the equilibrium positions of the discharge plumes were noted. Tests in a current are still in progress but some preliminary results are presented.

SOLAR RADIATION UTILIZATION

11646 (PB—293760) **Directory of solar energy research projects in India.** (Tata Energy Research Inst., Bombay (India)). Mar 1978. 231p. NTIS PC A11/MF A01.

This directory contains data on about 140 research projects in the area of solar thermal conversion and photovoltaic processes. As a reference tool, the book should help in greater communication and cross fertilization of ideas in the field of solar energy and provide a panoramic view of solar energy research in India. The directory is divided into four sections: subject categories, list of institutions, list of investigators, and project information sheets.

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 11435, 11595

11647 (BNL—27012) **Series solar heat pump and energy conservation.** Kush, E.A. (Brookhaven National Lab , Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 24p. (CONF-791204—13). Dep. NTIS, PC A02/MF A01.

From 2. Miami international conference on alternative energy sources; Miami Beach, FL, USA (10 Dec 1979).

An overview is given of the series solar heat pump concepts and the reasons why it can serve an important role in energy conservation in space heating. These are highlighted by elevated Coefficients of Performance (COP's) and the use of low-temperature potentially inexpensive solar collectors. The characteristics required of the subsystems and integrated system are detailed. Particular emphasis is given to the performance of the heat pump itself at high temperature source conditions corresponding to those of solar input, and recent laboratory results which demonstrate very high COP's using practical components are shown. The reasons why the high COP's are a necessary but not sufficient condition for competitive overall system performance are detailed and methods for applying the high COP's to an effective Solar Assisted Heat Pump (SAHP) system are discussed. Ongoing development work in the field is summarized.

11648 (DOE/CS/30108—T1) **Committee on the Challenges of Modern Society solar energy pilot study. First follow-up report, October 1979, pilot country: United States; co-pilot countries: Denmark and France. CCMS report No. 110.** (TPI, Inc., Beltsville, MD (USA)). Jan 1980. Contract AC02-79CS30108. 84p. Dep. NTIS, PC A05/MF A01.

During 1973 to 1978, over twenty nations participated in the NATO/CCMS Solar Energy Pilot Study, whose objective was to promote and accelerate the use of solar heating and cooling of buildings. The activities in this information exchange included (1) the regular reporting of national solar heating and cooling programs, (2) the development of a format for reporting the performance of solar heating and cooling systems, (3) the exchange of system performance reports, (4) the establishment of two specialized working groups for solar-assisted low energy dwellings and passive solar applications. At the conclusion of the pilot study in 1978, the participants formulated recommendations for continued action at the international level, as well as for action at the national level. This report describes the progress made in implementing those recommendations. In addition to detailing the steps taken to continue collaboration in various efforts initiated within the Solar Energy Pilot Study, the report contains papers on the 1979 status of the solar heating and cooling programs in seventeen CCMS countries.

11649 (DOE/CS/34145—1) **Experimental investigation of the Trombe wall. Final report, October 1977-March 1979.** Casperson, R.L.; Hocevar, C.J. (Energy Engineering Group, Inc., Golden, CO (USA)). 15 May 1979. Contract EG-77-G-04-4145. 203p. Dep. NTIS, PC A10/MF A01.

A variable geometry test facility was constructed and an experimental program conducted to investigate the performance characteristics of the Trombe wall, passive solar heating system. The principal objective met in the research project was the determination of representative values of wall gap thermocirculation parameters for various wall geometries. Velocity and temperature profiles in the wall gap were obtained for 2, 4, and 6-inch gap widths. Maximum values for the Grashof number under measured flow conditions ranged approximately from 6×10^8 for the 2-inch gap to 1.5×10^7 for the 6-inch gap, indicating laminar flow and possibly the initiation of transitional flow regimes at the higher Grashof numbers. Turbulent flow behavior was not exhibited within the relatively broad range of test conditions studied in this research, conditions typical of one-story Trombe walls employing practical geometries. A second objective accomplished in this research was the characterization of the Trombe wall thermal efficiency for a variety of operating conditions and wall geometries. Using data collected under essentially clear-sky conditions, collector efficiency curves similar to those commonly used to describe the performance of flat-plate solar collectors were developed for the Trombe wall. The efficiency plots were determined for 2, 4, and 6-inch gap widths using linear regression fits. These regression fits were sufficiently good to validate the applicability of this approach in describing Trombe wall performance.

11650 (DOE/NASA/TM—78251) **Computer program for assessing the economic feasibility of solar energy for single-family residences and light commercial applications.** Forney, J.A.; Walker, D.; Lanier, M. (National Aeronautics and Space Administration, Huntsville, AL (USA). George C. Marshall Space Flight Center; Computer Sciences Corp., Huntsville, AL (USA)). Sep 1979. Contract EX-76-A-29-1037. 148p. Dep. NTIS, PC A07/MF A01.

The technical feasibility of utilizing solar energy to meet domestic space heating and hot water loads for single family residences and light commercial applications has been clearly demonstrated. However, the economic feasibility is a complex problem requiring subjective judgments of the future value of key economic parameters, particularly conventional fuel escalation rates. In simplest terms, the prospective installer must decide whether he is willing to spend money now (to install a solar heating system) in order to save money later (lowered conventional fuel bills in the future). This report describes a computer program (SHCOST) used to perform economic analyses of the Operational Test Sites managed for DOE by MSFC as part of the National Solar Heating and Cooling Development Program. The computer program is user oriented and allows consideration of only the economic parameters which are important to the user problem. A life cycle cost and cash flow comparison is made between a solar heating system and a conventional system. The program assists in sizing the solar heating system. A sensitivity study and plot capability allow the user to select the most cost effective system configuration.

11651 (DOE/R5/10140—1) **Performance improvement of a solar heating system utilizing off-peak electric auxiliary. Semi-annual prog-**

ress report, June 18, 1979-December 31, 1979. Eltimsahy, A.H. (Toledo Univ., OH (USA)). Dec 1979. Contract FG02-79R510140. 10p. Dep. NTIS, PC A02/MF A01.

During the period 18 June 1979 through December 1979, a solar assisted heat pump system was designed, installed and operated in the University of Toledo Experimental Solar House. The heat pump system is capable of operating in a wide range of temperatures which is needed in a solar house utilizing off-peak storage from the electric utility. The complete system consists of 584.1 square feet of Libbey-Owens-Ford's flat plate solar collectors, a 5 horsepower compressor (Victaulic Corp.), an evaporator (Dunham-Bush), a condensor (Dunham-Bush), thermal storage units, and associated equipment. During the installation and initial operation of the system, numerous aspects of the feasibility of this system design have been evaluated. Many of these aspects point to the potentially improved operating performance of a solar heating system utilizing off-peak storage from the electric utility.

11652 (DSE—5171-2) **Design, fabrication and testing of a marketable waterwall component. Final technical report, 1 September 1978-31 August 1979.** Maloney, T.J.; Habib, V. (One Design, Inc., Winchester, VA (USA)). Aug 1979. Contract EM-78-C-01-5171. 70p. Dep. NTIS, PC A04/MF A01.

One Design, Inc., has designed and developed modular waterwall components that make up a system for passive solar space heating using a south-facing thermal storage wall. The modules can also be used as thermal mass storage for roof apertures and for greenhouse applications. The modules are constructed of fiberglass reinforced polyester and each is 95 inches long, 16.5 inches wide and 24.5 inches tall. Each module contains 94 gallons or 784 pounds of water. When stacked behind south glazing, they provide 52 Btu/°F per square foot of net glazed area. A stack of four modules has a height of 93.5 inches, suitable for an 8-foot interior ceiling; a stack of five modules is 116.5 inches high, suitable for a 10-foot interior ceiling. The modules are designed to stack on one another without requiring additional hardware and nest inside each other to reduce shipping costs. Prototype modules were fabricated and subjected to structural tests. They were found to be capable of supporting at least 4.8 times the load imposed by a five tank stack, well above the recommended safety factor of 2. Long term purity of the water in the containers was tested and evaluated and found to be within acceptable limits. Prototype modules were installed in One Design's Star Tannery House near Winchester, Virginia, and performance was extensively monitored from January to April, 1979. Based on the performance during the period, it has been estimated that the passive solar heating contribution would be 79.5% of the house's total heating requirement.

11653 (EPRI-ER—1206-SY) **Detailed designs and construction: individual load center - solar heating and cooling residential project. Summary report.** Nathanson, D.; Swanson, J.L. (Little (Arthur D.), Inc., Cambridge, MA (USA)). Nov 1979. 67p. Dep. NTIS, PC A04/MF A01.

Conceptual system designs for each of ten experimental solar/load managed residences are given. The five residences in Albuquerque, New Mexico are of conventional Southwest design with particular care being paid to energy conserving features and aesthetic integration of solar collectors. On Long Island, New York the houses will be slightly different in appearance, but designed with the same demanding standards as the Albuquerque houses. The design and procurement approach for the experimental subsystems (solar, load management, heat pump, and instrumentation and controls) were based upon a turnkey approach. Vendors were selected based on their response to performance specifications and drawings issued for each system. Solar equipment for the residences is of both liquid and air type. Careful attention was paid to integration of the solar collectors into the basic house architecture. Both hot water and space heating functions are provided for in the solar designs. The load management thermal storage systems will incorporate both buried and above ground tanks with the flexibility to operate at either half or full capacity. Heat pumps are to be used in each residence and will be of either a multimode design or multiple, conventional air-to-air and water source heat pumps. The instrumentation and control systems will be remote and field programmable based on microprocessor technology. All ten houses have been built, had their experimental systems installed and are currently occupied. Data retrieval and analysis have begun. (WHK)

11654 (ISM—206) **Preliminary study of passive solar heating performance and visual clarity for a Transwall structure.** McClelland, J.F.; Fuchs, R. (Iowa State Univ. of Science and Technology, Ames (USA); Ames Lab., IA (USA)). 1979. Contract W-7405-ENG-82. 7p. (CONF-790118—7). Dep. NTIS, PC A02/MF A01.

From 3. national passive solar conference; San Jose, CA, USA (11 Jan 1979).

The thermal performance of a new passive solar heating system called Transwall has been compared to that of Trombe wall and direct gain systems using thermal network models. The Transwall system is a visually transparent modular water wall which thermalizes a high percentage of incident solar radiation within a water based storage medium by absorption of the radiation in both the water and in a semitransparent plate positioned between the light transmitting walls of the water-filled modules. The Transwall structure allows vision to the exterior through the solar gain fenestration and provides a direct gain contribution to the building heating requirements. Because of the strong light attenuation by the Transwall, the direct gain operation of the system does not suffer from severe glare and photodegradation problems which occur in some direct gain interiors.

11655 (LA-UR—79-1897) **Adaptive optimal control: an algorithm for direct digital control.** Farris, D.R.; McDonald, T.E. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 32p. (CONF-800206—1). Dep. NTIS, PC A03/MF A01.

From American Society of Heating, Refrigeration, and Air Conditioning Engineers semi-annual meeting; Los Angeles, CA, USA (3 Feb 1980).

An algorithm for applying advanced control concepts in heating, ventilating, and air conditioning (HVAC) systems has been developed at the Los Alamos Scientific Laboratory (LASL). The algorithm uses optimal control and is adaptive in nature. Simulations for a solar heated and cooled building indicate that use of this algorithm can accomplish a substantial savings in auxiliary energy consumption. In this paper, the algorithm is described and its application is illustrated with a simple example. Simulation results for a more complex system are also presented. The hardware, including the digital computer, needed to implement this algorithm is briefly discussed.

11656 (LBL—9787) **Simple method for computing the dynamic response of passive solar buildings to design weather conditions.** Goldstein, D.B.; Lokmanhekim, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1979. Contract W-7405-ENG-48. 13p. (CONF-791204—16). Dep. NTIS, PC A02/MF A01.

From 2. Miami international conference on alternative energy sources; Miami Beach, FL, USA (10 Dec 1979).

In contrast to the length computations required to simulate hour-by-hour building performance using response-factor or thermal network models, design-day performance can be analyzed simply by using a method developed based on Fourier transforms. This paper describes how Fourier response functions are derived from the building's thermal properties and shows how approximations can be made which allow the results to be expressed as algebraic formulas which can be computed rapidly using a hand-calculator. A program written for a hand-calculator which can perform this analysis requires as inputs building design parameters such as UA products (conductances), specific heats of materials, and weather parameters. Since similar materials (e.g. frame walls and ceilings) can be lumped together, data for only a few different construction types are needed. Weather parameters are: daily solar gains for sunny and cloudy design days, length of cloudy design weather cycle, average ambient temperature of the design day and typical diurnal temperature fluctuation. Output from the program is hourly room temperatures for each of the design days.

11657 (N—79-20499) **Cost analysis and optimization study for solar heating and cooling systems.** Reid, W.L.; Shannon, R.E. (Alabama Univ., Huntsville (USA). Kenneth E. Johnson Environmental and Energy Center). Jan 1979. Contract NAS8-31293. 51p. NTIS, PC A04/MF A01.

Detailed cost analyses of two operational test sites which are a part of a solar energy development program are presented. Actual costs and potential cost improvements of new and retrofit solar space conditioning and hot water systems for single family sized housing were studied. Operational test sites were used for evaluation as these projects are a part of the National Solar Heating and Cooling Demonstration Program. During the period involved in the initial cost analysis of the solar project, it became evident that a comparison of solar system costs with conventional heating, cooling, and hot water systems on a first cost basis was not sufficient for an overall view of life cycle costs for the consumer.

11658 (N—79-20519) **An analytical investigation of the performance of solar collectors as nighttime heat radiators in airconditioning cycles. Final report.** Jones, C.B.; Smetana, F.O. (North Carolina Science and Technology Research Center, Research Triangle Park (USA)). Mar 1979. Contract NAS1-14208. 62p. NTIS, PC A04/MF A01.

It was found that if the upper and lower ends of a collector were opened, large free convention currents may be set up between the collector surface and the cover glass(es) which can result in appreciable heat rejection. If the collector is so designed that both plates surfaces are exposed to convection currents when the upper and lower ends of the collector enclosure are opened, the heat rejection rate is 300 watts sq m when the plate is 13 C above ambient. This is sufficient to permit a collector array designed to provide 100 percent of the heating needs of a home to reject the accumulated daily air conditioning load during the course of a

summer night. This also permits the overall energy requirements for cooling to be reduced by at least 15 percent and shift the load on the utility entirely to the nighttime hours.

11659 (SOLAR/2018—78/14) Solar energy system performance evaluation. Reedy Creek Utility District Office Building, Lake Buena Vista, Florida, March-August 1978. Wallace, C.T.; Brooks, A.R.; Murphy, L.J. (International Business Machines Corp., Huntsville, AL (USA)). 1978. Contract EX-76-C-01-2401;EG-77-C-01-4049. 44p. Dep. NTIS, PC A03/MF A01.

This system performance evaluation report presents a summary of the March through August 1978 operation of the Reedy Creek Utility District solar energy system. This system is designed to provide space heating and cooling as well as hot water for a two story modern office building located in Lake Buena Vista, Florida. Presented are results of an evaluation of measured system performance and a comparison of measured climatic data with long term average conditions. Performance evaluations of each of the major subsystems are also presented. (WHK)

11660 Solar energy assisted air-conditioning apparatus and method. Griffiths, W.C. (to Midland-Ross Corp.). US Patent 4,164,125. 14 Aug 1979. Filed date 17 Oct 1977. 8p.

An apparatus and a method for air-conditioning by which solar heat is collected and utilized in winter heating and in summer cooling and humidity adjustment is described. A hygroscopic liquid circulates through a solar heat collector and a reservoir, accumulating sufficient heat to furnish energy for dehumidification, adiabatic cooling of air, and concentrating of the hygroscopic liquid in summertime operation, or alternatively, heating of air in winter time.

11661 Field validation of the thermal performance of a passively heated building as simulated by the DEROB system. Arumi-Noe, F.; Northrup, D.O. (Univ. of Texas, Austin). *Energy Build.;* 2: No. 1, 65-75(Jan 1979).

Hourly thermal performance data for a passively solar heated house are compared with simulated data. The house, Solar Village 1, in Santa Fe, New Mexico, owned and occupied by the Douglas Balcomb family, has been instrumented and monitored since the 1976-1977 winter. The data reproduced here were collected in February 1978, including on-site micro-climatic weather data. The simulation is carried out with the computer program DEROB as developed at the Numerical Simulation Laboratory of the School of Architecture of the University of Texas at Austin.

11662 National solar heating and cooling information center. Lifsey, J.A.; Meschkow, S.Z. (National Solar Heating and Cooling Information Center, Rockville, MD). pp 6-13 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

The Center is an information service funded by the US Department of Housing and Urban Development and the US Department of Energy as part of a program to foster the use of solar energy in domestic hot water systems and the heating and cooling of buildings. The Center answers questions by mail and over toil-free hot lines, operates a mobile exhibit van and several exhibits that appear at conferences and trade shows, and distributes HUD and DOE publications on solar energy. Users can request lists of addresses of solar design and construction professionals, manufacturers, distributors, banks that have given solar mortgage or construction loans and solar films, slides, and video tapes. Users can also obtain information on solar design, equipment testing, standards, climatic data, HUD and DOE construction grants, state and federal tax incentive and solar land use and access legislation, solar courses and seminars, speakers on solar energy, and fact sheets and bibliographies on various aspects of solar energy. As of 9/1/78 the Center had processed 178,140 phone calls and 144,640 letters requesting solar information. A recent survey of 46,850 phone calls showed that 67% of the toll-free hot line users were private citizens and 33% were businessmen and professionals. 61.3% wanted general solar information and the next most popular topics were costs and payback, sources of equipment, HUD and DOE demonstration grants, and the state hot water initiative grants. Interest is weak in the southeastern states. Those interested in doing research on various aspects of the potential solar market should know that sections of the NSHCIC mailing list are available for a nominal fee.

11663 Toward a methodology for evaluation of solar systems. Moran, W.P.; Kouba, G.E.; Ketcham, B.V. (Univ. of Tulsa, OK). pp 141-146 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

The shortcomings and inconsistencies of the typical return-on-capital evaluation are detailed. Generalizations of evaluation objectives and performance measures and data gathering objectives are given.

11664 Long term stability of linearized thermistor circuits. Kouba, G. (Univ. of Tulsa, OK.). pp 155-157 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

The long term accuracy and stability of linearized thermistor circuits used for temperature measurements in a solar home monitoring project are being evaluated by periodic calibration.

11665 Design and operational characteristics of a retrofit solar heating system. Wetteroff, D.J.; Armaly, B.F. (Univ. of Missouri, Rolla). pp 341-347 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

The construction and the operation of a retrofit solar assisted space heating system on the campus of the University of Missouri-Rolla are described. Performance characteristics of each component were measured and used to estimate the contribution of solar energy to the yearly space heating energy requirements.

11666 Analysis of investments in residential energy conservation in Southeast Missouri. Gunderson, R. pp 485-489 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

This study examines the economic feasibility of residential solar heating. Climatic and economic variables used represent those of Cape Girardeau, Missouri. An annual cost model is used to determine the conditions under which solar heating achieves a reduced annual cost of heating relative to gas and electric heating systems.

11667 Combining solar heating with a wood burning furnace. Bechtold, K. (Lone Star Industries, Bonner Springs, KS); Stewart, W.E. Jr. pp 490-495 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

The objective is to minimize the use of high-cost heating fuels in rural areas with the assistance of a wood burning furnace and a solar collector. It was discovered that when the output of a wood burning furnace can be diverted into a solar storage battery, more useful heat can be supplied to a house with a little extra inconvenience to the homeowner. The total amortized system of the wood burning furnace combined with the solar system will be less than if the systems were operated independently.

11668 Solar-cooling pool assisted heat pump system. Schaetzle, W.J. (Univ. of Alabama, Tuscaloosa). pp 496-501 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

A swimming pool is used in parallel with a water-source heat pump for both cooling and heating. For cooling, the pool is used as a spray pond (cooling tower); and for heating, the pool is used as a solar collector, and thermal energy storage. Both theoretical studies and experimental work have been done on this system. A full scale system is almost complete and has been used during the summer for cooling. Economically, on both an operating basis and a capital basis, the system appears feasible.

11669 Energy evaluation and component characterization data in a residential solar monitoring program. Kouba, G.E.; Moran, W.P.; Ketcham, B.V. (Univ. of Tulsa, OK). pp 502-510 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

The initial phase of performance analysis, data acquisition system development and short term component characterization of a two-year residential solar energy monitoring program are presented. The purpose of the monitoring program is to accumulate both short and long term performance data which would be useful in optimizing system operation, determining possible improvements to the system configuration, validating simulation methods for predicting performance, and estimating the economics of the system.

11670 Analysis of solar heating costs in Arkansas broiler houses. Gunderson, R. (Southeast Missouri State Univ., Cape Girardeau); Redfern, J.M. pp 621-630 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

This study is based on the computer simulation model of a solar heated broiler house in four locations in Arkansas. This simulation model estimated the annual energy savings in each broiler house due to the installation of a solar heating system. This paper uses present value analysis to estimate the life cycle costs of heating conventional and solar heated broiler houses in the state of Arkansas. From these calculations, the number of years required to achieve a break-even cost of heating is estimated.

11671 Principles of design of a solar heated house. Stefanovic, A. (Ohio Edison Co., Akron); Kashkari, C. pp 631-636 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

The principles of design of a solar heating system for a house in the Akron, Ohio area are explained. The house is a standard one family, two story house, such as Ryan Home's Brockington model. It has, approximately, 2,000 square feet of living area, a full basement, and an attached two car garage. The solar heating system is designed to provide as much of the heating needs as is economically feasible.

11672 Architectural application for FCHART (solar feasibility in the midwest). Wright, R.; Dieckmann, L.; Wright, S.; Selby, R. pp 637-645 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

Examination of climatic conditions in the twelve Midwestern states of Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin reaveals that this region receives from 50% to 70% of the possible annual total hours of sunshine. Degree day heating requirments range from 4,000DD to over 10,000DD per year. In the northern tier of states, some areas require heat at some time in each month. The FCHART Method for Solar Heating Design, developed at the Solar Energy Laboratory at the University of Wisconsin, is a method for making a computer study of solar capability for selected cities in the United States. Thermal analysis of a selected typical housing unit was made by the FCHART method for thirty-two Midwestern cities. Percentage of heat provided by the sun varies from 87.8% in Dodge City, Kansas, to 70.5% in East Lansing, Michigan.

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

11673 (ATR.—78(76 91-04)-1) **New applications of high-temperature solar energy for the production of transportable fuels and chemicals and for energy storage.** (Aerospace Corp., Los Angeles, CA (USA). Energy and Resources Div.). 19 Jan 1979. Contract EY-76-C-03-1101. 178p. Dep. NTIS, PC A09/MF A01.

The solar fuels and chemicals study was limited to the examination of processes requiring temperatures in excess of 1000°K since lower temperature processes had already been examined in studies concerned with the application of waste heat from nuclear power plants to industrial processes. In developing the carbon cycle processes, the primary activity included an extensive literature search and the thermodynamic evaluation of a number of candidate chemical cycles. Although both hydrogen and carbon closed- and open-loop chemical cycles were studied, it was concluded that the carbon cycles offered sufficient additional potential to warrant concentrating on them in subsequent work. The section on new ideas for transportable fuels presents the elements of a new concept for a carbon cycle recovery technique to produce transportable fuels. The elements discussed are sources of carbon dioxide, solar energy reduction of CO_2, potential carbon cycles, and use of carbon monoxide as fuel and feedstocks. Another section presents some new concepts for the use of high-temperature solar energy in the production of essential materials and for closed-loop chemical storage, as well as for the production of hydrogen as a fuel and open-loop applications. Potential problem areas pertinent to solar-derived fuels and chemicals have been identified. These problems are primarily associated with the limited high temperature experience in industry and include materials compatibility, separation of reaction products, development of solid electrolytes and high-temperature electrodes, selective emission of receiver coatings at high temperature, and a lack of chemical kinetics data, and high-temperature thermodynamic data.

11674 (CONF-790328—P3, pp 99-109) **Storage for process heat applications.** Gordon, L.H. (Lewis Research Center, Cleveland, OH). 1979.

From Solar energy storage options workshop; San Antonio, TX, USA (18 Mar 1979).

The panel attempted to identify technology gaps, institutional concerns, the value of storage, and development elements for FY 80-85 implementation. The panel was charged with (1) providing choices and ranking of storage options for solar industrial and for solar agricultural processes heat application, and (2) recommending directions and priorities in FY 80-85 for storage concept development, subsystem development and system integration.

11675 (DOE/CS/32199—1) **Solar production of industrial process steam ranging in temperature from 300°F to 550°F (Phase I). Volume 1. Final report, September 30, 1978-June 30, 1979.** (Foster Wheeler Corp., Livingston, NJ (USA)). 30 Jun 1979. Contract ET-78-C-03-2199. 176p. Dep. NTIS, PC A09/MF A01.

This section summarizes the Foster Wheeler Development Corporation/Dow Chemical Company Phase I solar industrial process steam system and includes a system schematic, a brief system description, general specifications of the major system components, expected system performance, and a cost estimate summary for Phases II and III. The objectives of Phase I are: (1) design a cost-effective solar steam generating system, using state-of-the-art components and technology, to supply steam for Dow Chemical Company's Dalton, Georgia, plant; (2) predict the performance of the solar process steam plant; (3) conduct a safety evaluation and an environmental impact assessment of the solar steam system; (4) conduct an economic analysis to determine the potential economic benefits of a solar-augmented process steam production system compared with an existing fossil-fuel-fired steam generator; and (5) promote the project extensively to make it visible to industry and the general public.

11676 (DSE—4042-T15) **Solar energy for agricultural and industrial process heat.** (Solar Energy Research Inst., Golden, CO (USA)). 22 Jun 1979. Contract EG-77-C-01-4042. 30p. Dep. NTIS, PC A03/MF A01.

A state-of-the-art review of solar process heat is given; near term prospects are discussed; and the federal solar industrial process heat program is reviewed. Existing solar industrial process heat projects are tabulated. (WHK)

11677 (LA—8137-TASE) **Preliminary definition and characterization of a solar industrial process heat technology and manufacturing plant for the year 2000.** Prythero, T.; Meyer, R.T. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 34p. Dep. NTIS, PC A03/MF A01.

A solar industrial process heat technology and an associated solar systems manufacturing plant for the year 2000 has been projected, defined, and qualitatively characterized. The technology has been defined for process heat applications requiring temperatures of 300°C or lower, with emphasis on the 150° to 300°C range. The selected solar collector technology is a parabolic trough collector of the line-focusing class. The design, structure, and material components are based upon existing and anticipated future technological developments in the solar industry. The solar system to be manufactured and assembled within a dedicated manufacturing plant is projected to consist of the collector and the major collector components, including reflector, absorber, parabolic trough structure, support stand, tracking drive mechanism, sun-sensing device and control system, couplings, etc. Major manufacturing processes to be introduced into the year 2000 plant operations are glassmaking, silvering, electroplating and plastic-forming. These operations will generate significant environmental residuals not encountered in present-day solar manufacturing plants. Important residuals include chemical vapors, acids, toxic elements (e.g. arsenic), metallic and chemical sludges, fumes from plastics, etc. The location, design, and operations of these sophisticated solar manufacturing plants will have to provide for the management of the environmental residuals.In addition, national level evaluations of the economic and environmental impacts of expanded solar technologies will have to account for these new operations for new solar manufacturing plants that may be located at enlarged or new industrial sites across the nation.

11678 (SERI/TP—333-538) **Feasibility evaluation for solar industrial process heat applications.** Stadjuhar, S.A. (Solar Energy Research Inst., Golden, CO (USA)). Jan 1980. Contract EG-77-C-01-4042. 7p. (CONF-800101—3). Dep. NTIS, PC A02/MF A01.

From Systems simulation and economics analysis conference; San Diego, CA, USA (23 Jan 1980).

An analytical method for assessing the feasibility of Solar Industrial Process Heat applications has been developed and implemented in a flexible, fast-calculating computer code - PROSYS/ECONMAT. The performance model PROSYS predicts long-term annual energy output for several collector types, including flat-plate, nontracking concentrator, one-axis tracking concentrator, and two-axis tracking concentrator. Solar equipment cost estimates, annual energy capacity cost, and optional net present worth analysis are provided by ECONMAT. User input consists of detailed industrial process information and optional economic parameters. Internal program data includes meteorological information for 248 US sites, characteristics of more than 20 commercially available collectors representing several generic collector types, and defaults for economic parameters. Because a fullscale conventional back-up fuel system is assumed, storage is not essential and is not included in the model.

11679 (UCRL—83650) **Review of four DOE-sponsored low temperature steam systems.** Gerich, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Nov 1979. Contract W-7405-ENG-48. 7p. (CONF-791024—12). Dep. NTIS, PC A02/MF A01.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

The system characteristics and limited operating experience of four DOE-sponsored low temperature steam system field tests are described. The West Point Peperell (Honeywell) installation in Farifax, Alabama, has been operational for nine months but has experienced numerous minor equipment and system problems and a major

problem with its shadow bar tracker. The other three installations are not operational yet. Johnson and Johnson (Acurex) in Sherman, Texas, is currently in the startup and checkout phase and will be operational in December, 1979. Home Laundry (Jacobs-Del) in Pasadena, California, and Tropicana Products (General Electric) in Bradenton, Florida, are both well into the construction phase and expect to be operational in February, 1980.

WATER HEATING

REFER ALSO TO CITATION(S) 11648, 11650, 11653, 11659, 11662, 11669, 11672

11680 (SOLAR/2028—78/14) **Solar energy system performance evaluation, Hogate's Restaurant, Washington, DC, June through August 1978.** Aquila, V.S.; Brooks, A.R.; Murphy, L.J. (International Business Machines Corp., Huntsville, AL (USA)). 1978. Contract EG-77-C-01-4049. 40p. Dep. NTIS, PC A03/MF A01.

Hogate's Restaurant (located in Washington, DC) has 6,254 square feet of flat plate collectors used to support energy requirements for a hot water system. The restaurant requires approximately 7,000 gallons of hot water each day between 4:00 am and 2:00 pm. This hot water is used by the restaurant's kitchen facilities and must be supplied at 150°F. The solar energy system is a retrofit, and as such, the collectors face southwest instead of ideally facing south. The solar collector loop uses a mixture of 60% propylene glycol and 40% water as the heat transfer fluid. The potable water supply is isolated from the heat transfer fluid by a liquid to liquid heat exchanger. The collection and transfer of solar energy is controlled by the activation of two sets of pumps.

11681 Process and apparatus for obtaining hot water by use of solar energy. Morin, C. (to Pechiney Ugine Kuhlmann). US Patent 4,165,732. 28 Aug 1979. Priority date 18 Nov 1975, France, 10p.

A process and an apparatus for preparation of hot water using solar energy is set forth. In the process, the water is made to circulate successively in two reservoirs connected in series, and the water is heated from solar energy in one reservoir while the second reservoir can be heated by a known means, such as an electrical resistance. Continuous circulation of the water is created, in a closed loop, by a circulator pump which introduces at least a part of the water discharging from the second reservoir into the first reservoir.

11682 Computer modeling of a solar hot water collector system. Bregar, M.F. (Black & Veatch Consulting Engineers, Kansas City, MO); Stewart, W.E. Jr. pp 376-379 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

Computer modeling of a solar collector system can facilitate the selection of design paths and produce the optimal orientation and layout of the system for its intended location and seasonal usage patterns. Application of economic criteria to modeling also enables the analysis of alternate designs in terms of their installed and operating costs, as well as allowing calculation of payback periods for the various system configurations. This program was intended to aid in the design of solar hot water collector systems. Design parameters of the system are used as inputs to the program. System configuration and design can then be varied to study the effect of these parameters on overall system performance. The object is to optimize the design of the system around those system parameters which are fixed.

OTHER

11683 (UCRL—83634) **Solar furnace decomposition studies of $ZnSO_4$.** Hosmer, P.K.; Krikorian, O.H. (California Univ., Livermore (USA). Lawrence Radiation Lab.). 20 Nov 1979. Contract W-7405-ENG-48. 10p. (CONF-791143—1). Dep. NTIS, PC A02/MF A01.

From Users Association solar fuels workshop; Albuquerque, NM, USA (28 Nov 1979).

Several reasons are discussed why solar tests on the decomposition of zinc sulfate could be of value to sulfuric acid-based thermochemical cycles for the production of hydrogen. Included is a scheme using zinc sulfate to bypass many of the problems associated with the concentration of sulfuric acid. It is suggested that solar energy may be used to decompose the zinc sulfate, regenerating SO_2 as a reducing agent. Solar furnace characteristics discussed which may be of value to the sulfate decomposition reaction are high temperatures and rapid heating rates.

11684 Concentration of solar energy using a cassegrain type solar furnace. Cobble, M.H.; Hull, W.C. pp 348-355 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

A solar furnace consisting of a paraboloid of revolution that tracks the sun, and a hyperboloid of revolution reflector that has a focus in common with the paraboloid is analyzed using a three-dimensional ray trace to determine the image shape and size, and for the concentration to be obtained for various eccentricities e of the hyperboloid when used with an 84 foot diameter paraboloid (radar dish).

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 11438, 11476, 11512, 11513, 11514, 11566, 11677, 11682

11685 (ALO—4239) **3X CPC solar collector. Technical progress report, 7 May-7 November 1978.** Ballheim, R.W. (Chamberlain Mfg. Corp., Waterloo, IA (USA). Research and Development Div.). 22 Dec 1978. Contract ET-78-C-04-4239. 91p. Dep. NTIS, PC A05/MF A01.

A 2.6X concentrating high temperature, non-tracking solar energy collector has been designed and prototypes are being built. The key design criteria for optimization of the design was to obtain a maximum collector energy gain to cost ratio at an operating temperature of 400°F. The selected collector is about 4 feet by 9 inches deep and is a completely housed unit with a glass cover to protect the reflectors and receivers from the environment. There are six each 45-inch long CPC cusp-shaped reflector assemblies design-matched to the General Electric evacuated receiver. The reflector design is a truncated 4.1X CPC which requires the collector tilt angle to be adjusted four times each year. A ray tracing program was used in conjunction with a math model to calculate predicted annual heat gain for many collector configurations. These heat gains were then compared with the specific costs associated with each of the collector components to select the most cost effective collector design with an additional consideration being mass producibility of the collector. A serpentine design compatible with the selected collector and its operating conditions has been designed and tested. A survey of available heat transfer fluids has been completed and a fluid with properties acceptable for use in a collector system has been recommended.

11686 (ALO—15362-1) **Collector sealants and breathing. Mid-term report, September 25, 1978-May 30, 1979.** Mendelsohn, M.A.; Yeoman, F.A.; Luck, R.M.; Navish, F.W. Jr.; Meier, J.F. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). 1978. Contract AC04-78CS15362. 102p. Dep. NTIS, PC A06/MF A01.

The objectives of this program are: (1) to investigate the pertinent properties of a variety of possible sealants for solar collectors and identify the most promising candidates and to study the effect of breathing in flat-plate, thermal solar collector units. The study involves two types of sealants, Class PS which includes performed seals or gaskets and Class SC which includes sealing compounds or caulks. It is the intent of the study to obtain data regarding initial properties of candidate elastomers from manufacturers and from the technical literature and to use those sources to provide data pertaining to endurance of these materials under environmental service conditions. Where necessary, these data are being augmented by experimental measurements. Environmental stresses to be evaluated by these measuremets include elevated temperatures, moisture, ultraviolet light, ozone and oxygen, and fungus. The second major area of the work involves a study of the effects of materials used and design on the durability of solar collectors. Factors such as design, fabrication, materials of construction, seals and sealing techniques and absorber plate coatings were observed on actual field units removed from service. Such phenomena as leakage, corrosion and formation of deposits on glazing and absorber plate were noted. An evaluation of the properties of several desiccants is being made in order to provide means to mitigate the deleterious effects of water on collector life. Absorbents for organic degradation products of sealants are also being investigated in order to protect the glazing and absorber plate from deposited coatings. Since adsorbents and desiccants in general tend to take up both waer and organic decomposition products, relative affinities of a number of these agents for water and for organic compounds are being determined.

11687 (ASE—4371) **Development of a second-generation concentrating tracking solar collector. Technical progress report, 20 June-27 December 1978.** Miller, R.W. (American Science and Engineering, Inc., Cambridge, MA). 16 Jan 1979. Contract EM-78-C-04-4275. 58p. Dep. NTIS, PC A04/MF A01.

The objective of the work is to develop a second generation concentrating tracking solar collector. The approach combines a parabolic mirror concentrator with a variation of the cylindrical blackbody receiver to provide a minimum concentration ratio of ten. Performance characteristics are to be determined by tests using a prototype unit. Probable mass production costs for the collector will be generated. This report describes work performed during the first

six months of the contract effort. The design of the prototype collector has been completed. The collector design is described in detail. The performance analysis for the second generation collector was also completed during the first six months of the contract. The work consists of collector trade-off studies together with optical and thermal analysis of detailed configurations. The analysis is described in detail with computer programs included and results given for conditions of interest. The performance analysis was conducted in concert with the collector design effort. Thus, the collector design features were driven by performance considerations and design details are optimum with respect to performance. The result is a collector design capable of producing outlet field of high enough temperature to drive air conditioning equipment. Concentration ratio is 12 and predicted efficiency is 60% at fluid outlet temperature of 200°F. (WHK)

11688 (COO—4614-T1) **Protective coatings for front surface reflectors. Phase I, final report.** Dennis, W.E. (Dow Corning Corp., Midland, MI (USA)). Sep 1979. Contract ET-78-C-02-4614. 38p. Dep. NTIS, PC A03/MF A01.

Silicone resins were evaluated as protective coatings for front surface aluminum and silver reflectors. The solar weighted hemispherical reflectances and specular reflectances of float glass squares metallized with silver and aluminum and protected with silicone coatings were measured. The float glass squares metallized with silver and aluminum were highly reflective. The total reflectances of the silver samples were 5 to 7% higher than the aluminized samples. The resin coated aluminum samples were much more specular than the silver samples. Coupling agents used to improve the adhesion of the protective silicone resin coating to the silver surface adversely affected the specularities.

11689 (COO—4878-12) **High-temperature seal development for the share receiver.** Jarvinen, P.O. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1979. Contract ET-78-S-02-4878. 9p. (CONF-791221—2). Dep. NTIS, PC A02/MF A01.

From Semiannual conference for advanced solar thermal technology; Phoenix, AZ, USA (11 Dec 1979).

The development and experimental demonstration of a high-temperature seal for the SHARE ceramic dome cavity receiver is reported. The mechanical contact seal which was tested on one-foot diameter silicon carbide ceramic dome hardware at pressure differentials to four atmospheres and dome temperatures to 2200°F (1200°C) showed negligible leakage at expected receiver operating conditions.

11690 (N—79-20491) **The parabolic concentrating collector: a tutorial.** Truscello, V.C. (Jet Propulsion Lab., Pasadena, CA (USA)). 1 Mar 1979. Contract NA S7-100. 47p. NTIS, PC A03/MF A01.

A tutorial overview of point-focusing parabolic collectors is presented. Optical and thermal characteristics are discussed. Data representing typical achievable collector efficiencies are presented and the importance of balancing collector cost with concentrator quality is argued through the development of a figure of merit. Various types of two-axis tracking collectors are described. The Department of Energy program to develop these devices is briefly discussed, as are present and projected costs for these collectors.

11691 (N—79-20495) **Performance characteristics of a 1.8 by 3.7 meter Fresnel lens solar concentrator.** Hastings, L.J.; Allums, S.L. (National Aeronautics and Space Administration, Huntsville, AL (USA). George C. Marshall Space Flight Center). 12 Feb 1979. 25p. NTIS, PC A02/MF A01.

Line-focusing acrylic Fresnel lenses with application potential in the 200 to 370 C range were analytically and experimentally investigated. The measured solar concentration characteristics of a 1.8 by 3.7 m lens and its utilization in a solar collection mode are presented. A measured peak concentration ratio of 62 with 90 percent of the transmitted energy focused into a 5.0cm width was achieved. A peak concentration of 59 and a 90 percent target width of 4.3 cm were analytically computed. The experimental and analytical lens transmittance was 78 percent and 86 percent, respectively. The lens was also interfaced with a nonevacuated receiver assembly and operated in the collection mode. With a natural oxide absorber tube coating (alpha/epsilon = 0.79/0.10), the measured collection efficiency ranged from 43 percent to 200 C to 34 percent at 260 C. Efficiency improvements to the 40 to 50 percent range can be achieved with second generation lenses and higher performance absorptive coatings.

11692 (PNL-SA—7698) **Solar reflector materials.** Lind, M.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1979. Contract EY-76-C-06-1830. 23p. (CONF-7905134—1). Dep. NTIS, PC A02/MF A01.

From WSPE seminar on high-level solar energy; Seattle, WA, USA (18 May 1979).

A brief overview is given of the current state-of-the-art in solar reflector materials. Its purpose is to outline the uses of reflectors in the solar industry and present some insights into the operational and materials considerations that must be incorporated into the solar reflector design. Current problem areas and research goals will be emphasized.

11693 (SERI/TP—334-457) **Solar reflectance, transmittance, and absorptance of common materials.** Butler, B.L.; Call, P.J.; Jorgensen, G.L.; Pettit, R.B. (Solar Energy Research Inst., Golden, CO (USA)). Oct 1979. Contract EG-77-C-01-4042. 8p. (CONF-791024—9). Dep. NTIS, PC A02/MF A01.

From Solar industrial process heat conference; San Francisco, CA, USA (31 Oct 1979).

The solar reflectance, transmittance, and absorptance of common materials used for solar collector fabrication have been compiled for easy reference. The data are derived from solar weighted averaging techniques and can be used for initial calculations of collector performance.

11694 (SERI/TP—351-559) **SOLPOND: a simulation program for salinity gradient solar ponds.** Henderson, J.; Leboeuf, C.M. (Solar Energy Research Inst., Golden, CO (USA)). Jan 1980. Contract EG-77-C-01-4042. 7p. (CONF-800101—4). Dep. NTIS, PC A02/MF A01.

From Systems simulation and economics analysis conference; San Diego, CA, USA (23 Jan 1980).

A computer simulation design tool was developed to simulate dynamic thermal performance for salinity gradient solar ponds. Dynamic programming techniques allow the user significant flexibility in analyzing pond performance under realistic load and weather conditions. Finite element techniques describe conduction heat transfer through the pond, earth, and edges. Results illustrate typical thermal performance of salinity gradient ponds. Sensitivity studies of salty pond thermal performance with respect to geometry, load, and optical transmission are included. Experimental validation of the program with an operating pond is also presented.

11695 **Guideline for certification of solar energy equipment.** Sacramento, CA; California Energy Commission (1978). 57p. (NP—24096).

The criteria which the state of California will use to certify solar energy equipment marketed in the state are identified. It establishes inspection, test and analytical requirements that must be met by solar equipment manufacturers. It also describes the activities of solar equipment manufacturers, solar equipment test laboratories, and the California Energy Commission. The publication specifically establishes standards and procedures for the testing and labeling of flat-plate collectors used in solar energy systems. The scope of certification will be extended to cover entire solar hot water systems and other equipment used in complete systems, such as controls, heat exchangers, unglazed collectors, and storage devices.

11696 **Commercially available vacuum tube solar collectors.** Ring, S.J. (Hallmark Cards, Inc., Kansas City, MO). pp 356-361 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

Efficiencies on the order of 50% with high differential temperature (150°C) have been advertised with the current distribution of commercially available evacuated tube collectors. Product specifications and, where possible, experimental data have been gathered and presented. The paper also develops a mathematical model for evaluation of these collectors. Results conclude that, although performance is high, collector expense limits the cost effectiveness to necessary high-temperature, high-volume applications. These include both residential cooling and industrial processing.

11697 **Testing of solar collectors by a standard method.** Sauer, H.J. Jr.; Armaly, B.F. (Univ. of Missouri, Rolla). pp 362-366 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

A description of the recently adopted standard for testing solar collectors ASHRAE Standard 93-77, Method of Testing Solar Collectors Based on Thermal Performance, is presented. Results from the standard could be used to simulate the transient performance of an installed solar system.

11698 **Electromagnetic radiation energy arrangement.** Lipkis, R.R.; Vehrencamp, J.E. US Patent 3,173,801. 16 Mar 1965. Filed date 26 May 1961. 4p.

A solar energy collector and infrared energy reflector is described which comprises a vacuum deposited layer of aluminum of approximately 200 to 400 Angstroms thick on one side of a substrate. An adherent layer of titanium with a thickness of between 800 and 1000 Angstroms is vacuum deposited on the aluminum substrate and is substantially opaque to solar energy and substantially transparent to infrared energy.

HEAT STORAGE

REFER ALSO TO CITATION(S) 11633, 11673, 11694

11699 (BCS—40252) **Developing and upgrading of solar system thermal energy storage simulation models. Technical progress report, September 1, 1978-February 28, 1979.** Kuhn, J.K.; von Fuchs, G.F.; Zob, A.P. (Boeing Computer Services Co., Seattle, WA (USA). Energy Technology Applications Div.). May 1979. Contract EG-77-C-02-4482. 70p. Dep. NTIS, PC A04/MF A01.

The purpose of this project is to select and upgrade solar energy storage models, incorporate these models into a computer simulation, validate the model with comparisons to measured data, and make these models available for use by engineering and architectural organizations. Progress is reported. The rock bed model selected for validation was further explored and compared to test data. Correlation with data from different experiments is showing improvement over the correlations reported in the last six month progress report. The present model is considered acceptable at this time but more confirmation of its accuracy would be desirable. Two more water tank models have been obtained, one from the University of Alabama and one from Colorada State University (CSU). Work has continued with model testing, validation and evaluation. Additional laboratory test data on water tank performance has been obtained. Some significant improvements have been made in the SOLSYS algorithm resulting in a more powerful simulation tool referred to as the Extended SOLSYS Model. That and the CSU model have been selected for streamlining and for incorporation into TRNSYS. (WHK)

11700 (CONF-790328—P3) **Proceedings of solar energy storage options. Volume II.** McCarthy, M.B. (ed.). (Trinity Univ., San Antonio, TX (USA)). 1979. Contract W-7405-ENG-26;W-31-109-ENG-38. 154p. Dep. NTIS, PC A08/MF A01.

From Solar energy storage options workshop; San Antonio, TX, USA (18 Mar 1979).

Separate abstracts were prepared for each of the six included sections. (MOW)

11701 (CONF-790328—P3, pp 5-26) **Central storage for building heating.** Michaels, A.I. (Argonne National Lab., IL). 1979.

From Solar energy storage options workshop; San Antonio, TX, USA (18 Mar 1979).

As the essential first step in its assessment, the panel identified and analyzed the requirements imposed on the storage subsystem by the characteristics and needs of the overall solar energy building heating system. With these requirements in mind, the possible options for the storage component were considered, problems and inadequacies in the current state-of-the-art were identified, and recommendations were formulated for the storage development work which should be undertaken in each of the four major storage media categories (rockbeds, various types of water tanks, phase change materials and thermo-chemical heat pump/storage systems).

11702 (CONF-790328—P3, pp 29-70) **Annual cycle storage for building heating and cooling.** Eissenberg, D.M. (Oak Ridge National Lab., TN). 1979.

From Solar energy storage options workshop; San Antonio, TX, USA (18 Mar 1979).

The modes of annual cycle storage of thermal energy for heating and cooling which were considered by the panel included: (1) aquifers, (2) insulated ponds, (3) earth, (4) salt gradient ponds, (5) tanks, and (6) thermochemical.

11703 (CONF-790328—P3, pp 73-96) **Storage for solar electric heat pump combinations.** Andrews, J.W. (Brookhaven National Lab., Upton, NY). 1979.

From Solar energy storage options workshop; San Antonio, TX, USA (18 Mar 1979).

The panel's deliberations fell into two broad areas, design requirements and storage options. Under design requirements we considered technical and economic constraints which affect the applicability of solar systems in general and solar assisted heat pump systems in particular. Desired characteristics for storage elements were also treated, as were system reliability and utility interface.

11704 (CONF-790328—P3, pp 123-138) **Storage in building materials for heating and cooling.** Kedl, R.J. (Oak Ridge National Lab., TN). 1979.

From Solar energy storage options workshop; San Antonio, TX, USA (18 Mar 1979).

Considerable interest was shown in building materials that store heat (or cool) by utilizing the heat of fusion of a Phase-Change Material (PCM). This interest stems from the two principal advantages of PCM's for storage: First, the isothermal nature of storage, which may have considerable impact in the passive solar area from the point of view of human comfort, by reducing the temperature swings often experienced in a sensible heat storage system. Second, the high energy storage densities, and thus the low material mass for storing large quantities of heat, will have an impact on building structural requirements, particularly in retrofit and multi-story situations where weight is critical. The panel's recommendations reflect the newness of these materials which are only beginning to come out of the laboratory.

11705 (CONF-790328—P3, pp 141-153) **Central storage for building cooling.** Wahlig, M. (Univ. of California, Berkeley). 1979.

From Solar energy storage options workshop; San Antonio, TX, USA (18 Mar 1979).

The importance of each identified task was debated energetically by the panelists. Each was eventually assigned a priority ranking, either by general consensus or by an averaging procedure; for the latter cases, strongly divergent opinions were noted in the report. The tasks recognized as first priority included: (1) Carry out systems analysis calculations to evaluate trade-offs of cold-side vs hot-side storage, single vs multiple storage stages, phase change vs sensible heat storage, and storage capacity vs use of auxiliary backup energy. (2) Determine why some existing systems with storage do not perform as designed; follow up with corrective measures. (3) Discover or develop more durable insulation for storage vessels. (4) Identify or develop tank construction methods that eliminate leaks at penetrations through the tank liner or at joints in the vessel structure. (5) Disseminate corrosion information.

11706 (SERI/RR—351-347) **Simple design tool for sizing solar ponds.** Edesess, M.; Henderson, J.; Jayadev, T.S. (Solar Energy Research Inst., Golden, CO (USA)). Dec 1979. Contract EG-77-C-01-4042. 42p. Dep. NTIS, PC A03/MF A01.

This report presents a simple tool and method of analysis to aid practitioners in the planning and implementation of solar energy systems. This simple design tool for sizing solar ponds should aid analysts and planners in assessing the feasibility of solar ponds for any specified application, and in drawing up a preliminary plan for their implementation.

GEOTHERMAL ENERGY

RESOURCE STATUS AND ASSESSMENT

REFER ALSO TO CITATION(S) 11793, 12001

USA

REFER ALSO TO CITATION(S) 11744, 11745, 11746, 11747, 11797, 11804, 12053

11707 (APL/JHU/QM—79-163/GT) **Evaluation of potential geothermal resource areas.** Mitchell, F.O. (Johns Hopkins Univ., Laurel, MD (USA). Applied Physics Lab.). Jul 1979. Contract EX-76-A-36-1008. 50p. Dep. NTIS, PC A03/MF A01.

A method for the comparative evaluation of geothermal prospects in the Eastern United States is proposed and illustrated. Comparisons are based on quantified data from geologic, engineering, and socio-economic sources including temperature gradient, depth to basement, drilling costs, population, and distribution by town size, as well as energy use in residential, commercial, and industrial applications.

11708 (COO—4362-5) **Geothermal reservoir site evaluation in Arizona. Semi-annual progress report, July 15, 1978-January 15, 1979.** Hahman, W.R. Sr. (Arizona Univ., Tucson (USA). Bureau of Geology and Mineral Technology). Mar 1979. Contract EG-77-S-02-4362. 101p. Dep. NTIS, PC A06/MF A01.

Four papers are included. Separate abstracts were prepared for each one. (MHR)

11709 (COO—4362-5, pp 1-25) **Overview of the geothermal potential of the Springerville Area, Arizona.** Stone, C. Mar 1979.

In Geothermal reservoir site evaluation in Arizona. Semi-annual progress report, July 15, 1978-January 15, 1979.

Various geological, geochemical and geophysical data have been presented describing the geothermal characteristics of the Springerville area. Reactivation of partial melting in the upper mantle along regional zones of fundamental lithospheric weakness has resulted in recurrent volcanism since about 38 million years B.P. Anomalous Na-K-Ca geochemical thermometers occur near Lyman Lake, coincident with: (1) young travertine deposits, (2) anomalous in situ temperatures, and (3) anomalously high geothermal gradients. High silica concentrations are found further south, with slight overlap of both geochemical geothermometers at the town of Springerville. Geophysical data reveal a large negative residual Bouguer gravity anomaly and an electrical resistivity low stacked over the area between Springerville and Alpine. Additional studies from the

literature present evidence for a pronounced low velocity zone, a mantle upwarp, and a rise in the Curie isotherm beneath the region.

11710 (COO—4362-5, pp 42-72) **Preliminary report on the geothermal energy potential of the Safford basin southeastern Arizona.** Witcher, J.C. Mar 1979.

In Geothermal reservoir site evaluation in Arizona. Semiannual progress report, July 15, 1978-January 15, 1979.

Preliminary study of the Safford area shows an excellent geothermal potential for low and intermediate temperature reservoirs. Available geothermometry and gradient data predict 50°C to 120°C geothermal water at reasonable depths (760m to 1200m). The basal conglomerate facies of the lower basin fill is the most likely reservoir and probably stores a large volume of hot water. Very good artesian flows are probable as was reported in 1938 at the Mary Mack well near Pima. Sodium chloride water with high fluoride content is likely. Total dissolved solids ranging from 1000 mg/l to 10,000 mg/l or greater would be expected. Good geothermal reservoirs are also likely in alluvial channel deposits in the green clay facies along the basin margins. (MHR)

11711 (COO—4362-5, pp 73-91) **Preliminary study of the geothermal potential of the Tucson metropolitan area.** Witcher, J.C. Mar 1979.

In Geothermal reservoir site evaluation in Arizona. Semiannual progress report, July 15, 1978-January 15, 1979.

Assessment of low temperature geothermal resources (< 90°C) of the Tucson metropolitan area is under preliminary investigation. The geologic environment of the Tucson basin is reviewed with respect to possible heating mechanisms and hot-water storage sites. (MHR)

11712 (DOE/ID/12010—1) **Idaho geothermal commercialization program. Semi-annual report, January-June 1979.** McClain, D.W.; Eastlake, W.B. (Idaho State Office of Energy, Boise (USA)). 1979. Contract FC07-79ID12010. 19p. Dep. NTIS, PC A02/MF A01.

The task accomplished during the first six months of the cooperative agreement between the US Department of Energy and the Idaho Office of Energy is summarized, concentrating on geothermal resource data, regional and local development plans, energy and economic factors and institutional factors.

11713 (IDO—78-1701.b.5A) **Geothermal exploration and assessment technology program plan. Final report.** (Utah Univ., Salt Lake City (USA). Dept. of Geology and Geophysics). 30 Oct 1978. Contract EG-78-C-07-1701. 119p. Dep. NTIS, PC A06/MF A01.

The following program plan elements are described: barriers to commercialization, cost/benefit analysis for exploration assessment technology (hydrothermal systems), goals, objectives, technical plan, management plan, budget, and procurement plan. (MHR)

11714 (NATO/CCMS—66, pp 329-340) **Non-electrical geothermal applications in Alaska: a status report.** Forbes, R.B. (Univ. of Alaska, Fairbanks); Ogle, W.E. Jul 1978.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

Alaska geothermal resources are assessed. The status of geothermal research and development in Alaska is summarized, including active and planned projects. (MHR)

NON-USA

11715 (NATO/CCMS—66, pp 77-80) **Geothermal activities in Canada.** Jessop, A.M. (Dept. of Energy, Mines, and Resources, Ottawa, Ontario). Jul 1978.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

Geothermal research in Canada is summarized in two main areas: the volcanic zones of the western mountains and the sedimentary basins of the Prairie Provinces. (MHR)

11716 (NATO/CCMS—66, pp 319-327) **Nonelectric applications of geothermal resources at Desert Hot Springs, California.** Nakamura, Y. (Jet Propulsion Lab., Pasadena, CA); Rogers, H. Jr.; Gibson, W.L. Jul 1978.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

A status report is given of an evaluation of potential nonelectric applications of an identifiable geothermal energy resource underlying the City of Desert Hot Springs, California. The effort is focusing upon a reservoir-specific, multi-use applications for the City and how the example study relates to regional needs. Hydrological data obtained during the wellflow experiment of a representative well indicate a specific yield approximately three times that necessary to support industrial projects, with minimal deleterious drawdown effects upon neighboring wells. Conceptual approaches have been formulated to show promise of thermodynamically harnessing the indigenous low-quality hydrothermal resources for implementing space conditioning as well as agribusiness operations.

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

USA

REFER ALSO TO CITATION(S) 11709, 11710, 11711, 11728, 11729, 11732

11717 (COO—4362-5, pp 26-41) **Progress report of geothermal investigations in the Clifton area.** Witcher, J.C. Mar 1979.

In Geothermal reservoir site evaluation in Arizona. Semiannual progress report, July 15, 1978-January 15, 1979.

Previous studies in the Clifton area are reviewed briefly. preliminary chemical geothermometry studies of Clifton Hot Springs are presented. (MHR)

11718 (IDO—1601-T5) **Attempt at paleomagnetic dating of opal, Roosevelt Hot Springs KGRA.** Brown, F.H. (Utah Univ., Salt Lake City (USA). Dept. of Geology and Geophysics). Feb 1977. Contract EY-76-S-07-1601. 15p. Dep. NTIS, PC A02/MF A01.

The results of paleomagnetic investigation of a drill core from the Opal Dome at Roosevelt Hot Springs are reported. A log of the core from 1.5 to 16.8 m is given. (MHR)

11719 (ORO—5554-1) **Sandstone consolidation analysis to delineate areas of high-quality reservoirs suitable for production of geopressured geothermal energy along the Texas Gulf Coast.** Loucks, R.G.; Dodge, M.M.; Galloway, W.E. (Texas Univ., Austin (USA). Bureau of Economic Geology). Jan 1979. Contract EG-77-S-05-5554. 103p. Dep. NTIS, PC A06/MF A01.

Analysis of reservoir quality of lower Tertiary sandstones along the Texas Gulf Coast delineates areas most favorable for geopressured geothermal exploration. Reservoir quality is determined by whole core, acoustic log, and petrographic analyses. The Wilcox Group has good reservoir potential for geopressured geothermal energy in the Middle Texas Gulf Coast and possibly in adjacent areas, but other Wilcox areas are marginal. The Vicksburg Formation in the Lower Texas Gulf Coast is not prospective. Reservoir quality in the Frio Formation increases from very poor in lowermost Texas, to marginal into the Middle Texas Gulf Coast and to good through the Upper Texas Gulf Coast. The Frio Formation in the Upper Texas Gulf Coast has the best deep-reservoir quality of any unit along the Texas Gulf Coast. (MHR)

11720 (IDO—78-1701.a.1.1.5) **Hydrothermal alteration at the Roosevelt Hot Springs Thermal Area, Utah: modal mineralogy, and geochemistry of sericite, chlorite, and feldspar from altered rocks, Thermal Power Company well Utah State 14-2.** Ballantyne, J.M. (Utah Univ., Salt Lake City (USA). Dept. of Geology and Geophysics). Nov 1978. Contract EG-78-C-07-1701. 50p. Dep. NTIS, PC A03/MF A01.

Sericites, chlorites, feldspars, biotite and hornblende from hydrothermally altered rocks at several depths in Thermal Power Company well Utah State 14-2, Roosevelt Hot Springs Thermal Area, Utah, have been analyzed using the electron microprobe. Sericites and ferromagnesian minerals have been analyzed for 12 major elements, and feldspars for 3. The results have been used, along with whole rock chemical analyses, to computer calculate modal mineralogy for samples from the drillhole. Calculated modes for hydrothermal minerals are in reasonable agreement with observations from thin sections.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

REFER ALSO TO CITATION(S) 11709, 11713

11721 (ID—1601-T15) **Geothermal research, Roosevelt Hot Springs area. Quarterly progress report, May 1-July 31, 1978.** Bowman, J.R.; Brown, F.H.; Cook, K.L. (Utah Univ., Salt Lake City (USA). Dept. of Geology and Geophysics). 1978. Contract EY-76-S-07-1601. 9p. Dep. NTIS, PC A02/MF A01.

Completed research programs are listed. Brief status reports are given on those still in progress. The program budget is shown (MHR)

11722 (IDO—1701-T1) **Program review: resource evaluation, reservoir confirmation, and exploration technology.** Ward, S.H. (Utah Univ., Salt Lake City (USA). Dept. of Geology and Geophysics). May 1978. Contract EG-78-C-07-1701. 192p. Dep. NTIS, PC A09/MF A01.

The details of the program review are reported. A summary of the recommendations, means for their implementation, and a six year program of expenditures which would accomplish the objectives of the recommendations are presented. Included in appendices

are the following: DOE/DGE consortia participants; program managers contacted for opinion; communications received from program managers; participants, program review panel; and program strategy for resource evaluation and reservoir confirmation. (MHR)

11723 (ORO—5243-T1) **United States Gulf Coast Geopressured Geothermal Program: special projects research and coordination assistance. Final report, October 1, 1977-November 30, 1978.** Dorfman, M.H.; Bebout, D.G. (Texas Univ., Austin (USA). Center for Energy Studies; Texas Univ., Austin (USA). Bureau of Economic Geology). Apr 1979. Contract EY-76-S-05-5243. 133p. Dep. NTIS, PC A07/MF A01.

The activities involved in the coordination assistance function are reviewed including: technical assistance and liaison; technical assistance for review and evaluation of proposals and contract results; technical assistance and coordination for geopressure geothermal test well; technical assistance, coordination, and planning of surface component test facility; legal research in geopressure geothermal resource development; and operation of geopressure geothermal information service. This function takes the form of providing liaison with various industrial components that participate in the program and with state and local agencies. (MHR)

GEOPHYSICAL TECHNIQUES AND SURVEYS

11724 (COO—4342-1) **Magnetotelluric interpretations in a crustal environment. Semi-annual progress report, June 1, 1977-December 30, 1977.** Madden, T.R. (Massachusetts Inst. of Tech., Cambridge (USA)). Feb 1978. Contract EG-77-S-02-4342. 24p. Dep. NTIS, PC A02/MF A01.

A generalized thin layer analysis is described which includes a conductive layer and a resistive layer into a single layer. The equations describing the thin layer effects are reviewed and examples of comparisons between thin layer and generalized thin layer calculations are shown. Implementation of multiple scale analysis to allow the handling of large models in reasonable fashion was investigated. Some tests of these ideas on one-dimensional models are described. (MHR)

11725 (HIG—78-8) **Seismic studies on Kilauea volcano, Hawaii Island. Geothermal resources exploration in Hawaii: Number 5.** Suyenaga, W.; Broyles, M.; Furumoto, A.S.; Norris, R.; Mattice, M.D. (Hawaii Inst. of Geophysics, Honolulu (USA)). Nov 1978. Contract EY-76-C-03-1093. 124p. Dep. NTIS, PC A06/MF A01.

This volume contains six reports on seismological studies done in conjunction with other geophysical and geochemical studies of the Hawaii Geothermal Project. The studies were conducted on the easternmost portion of the East Rift Zone of Kilauea volcano, near the eventual site of the initial well, HGP-A, drilled by the Hawaii Geothermal Project. Separate abstracts were prepared for each report. (MHR)

11726 (HIG—78-8, pp 41-56) **Microearthquake study of the Opihikao anomaly, Puna, Hawaii.** Mattice, M.O.; Furumoto, A.S. (Univ. of Hawaii, Honolulu). Nov 1978.

In Seismic studies on Kilauea volcano, Hawaii Island. Geothermal resources exploration in Hawaii: Number 5.

A reconnaissance microearthquake survey over an electrical anomaly on the lower east rift zone of Kilauea volcano, Hawaii, recorded 8.5 earthquakes per day. It was concluded that the seismic level detected is normal for this area. Coincidence of the electrical anomaly and the seismic activity is striking. This geophysical evidence coupled with geologic evidence suggest geothermal sources. It is recommended that a well be drilled within this anomaly to a depth of at least two kilometers.

11727 (HIG—78-8, pp 77-92) **Crustal structure of the east rift zone of Kilauea, Hawaii from seismic refraction. 1. Near-surface structure.** Suyenaga, W. (Univ. of Hawaii, Honolulu). Nov 1978.

In Seismic studies on Kilauea volcano, Hawaii Island. Geothermal resources exploration in Hawaii: Number 5.

A seismic refraction survey designed to provide the near-surface seismic structure of the axis and flank of the east rift zone of Kilauea volcano was carried out in January 1976. Results reveal a surface layer of very low velocity (0.7 to 1.6 km/sec), which is probably interlayered lava flows with very large voids. Beneath the surface layer, velocities of 2.5 km/sec on the flank and 3.1 km/sec on the rift are observed. The change in velocity between the surface and second layer probably reflects the saturation of water at the water table. This structure differs from previous models based on studies which, because of the shot receiver distances, could not distinguish the surface layer.

11728 (HIG—78-8, pp 93-121) **Crustal structure of the lower east rift zone of Kilauea, Hawaii from seismic refraction. 2. Complete structure.** Broyles, M.L.; Furumoto, A.S. (Univ. of Hawaii, Honolulu). Nov 1978.

In Seismic studies on Kilauea volcano, Hawaii Island. Geothermal resources exploration in Hawaii: Number 5.

In 1977 seismic refraction survey of the Puna region of the East Rift Zone of Kilauea was an attempt to interpret the structure within the east rift outlining the arrangement of the dike intrusions and their relationship to the regional crustal structure. Previous studies of the crustal structure of Hawaii have either used long refraction lines that could not delineate the fine structure in the rift zones or short refraction lines unable to penetrate of the depth of the high velocity material comprising the intrusive dike complex. From this study, it is concluded that the depth to the top of the intrusive complex averages 2 to 2.5 km. Other studies indicate that the lower limit of the intrusion is at 4 to 5 km. This analysis also suggests that the subsurface lateral extent of the rift complex is much wider, 12 to 19 km, than the surface expression would indicate. A northward dip of 6 to 9° on the upper surface of the main complex is compatible with the seismic refraction and gravity data and suggests lateral development of the rift to the south.

11729 (HIG—78-8, pp 123-137) **Thermal processes of Kilauea east rift inferred from seismic data.** Furumoto, A.S. (Univ. of Hawaii, Honolulu). Nov 1978.

In Seismic studies on Kilauea volcano, Hawaii Island. Geothermal resources exploration in Hawaii: Number 5.

Seismic data provided insight into the tectonic and thermal processes of Kilauea east rift. Microearthquakes outlined a region with a volume of 7 km^3 around the exploratory well HGP-A. The region probably represents a geothermal reservoir. The earthquakes also outlined a discontinuity at 5-km depth, which is thought to be the unconformity between the volcanic edifice and oceanic crust. Source mechanism data showed that tensional forces are in operation over the east rift. These tensional forces are produced by an expanding rift zone due to forceful intrusion of magma from the summit holding reservoir. The result is formation of fractures in the layers above a hot dike complex. Groundwater seeping into the fractures is eventually trapped by a self-sealing process to form geothermal reservoirs.

11730 (IDO—77-5-6) **Dipole-dipole resistivity survey of a portion of the Coso Hot Springs KGRA, Inyo County, California.** Fox, R.C. (Utah Univ., Salt Lake City (USA). Research Inst.). May 1978. Contract EY-76-S-07-1601. 61p. Dep. NTIS, PC A04/MF A01.

A detailed electrical resistivity survey of 54 line-km was completed at the Coso Hot Springs KGRA in September 1977. This survey has defined a bedrock resistivity low at least 4 sq mi (10 sq km) in extent associated with the geothermal system at Coso. The boundaries of this low are generally well defined to the north and west but not as well to the south where an approximate southern limit has been determined. The bedrock resistivity low merges with an observed resistivity low over gravel fill east of Coso Hot Springs. A complex horizontal and vertical resistivity structure of the surveyed area has been defined which precludes the use of layered-earth or two-dimensional interpretive models for much of the surveyed area. In general the survey data indicate that a 10 to 20 ohm-meter zone extends from near surface to a depth greater than 750 meters within the geothermal system. This zone is bordered to the north and west by bedrock resistivities greater than 200 ohm-meters and to the south by bedrock resistivities greater than 50 ohm-meters. A combination of observed increases in: (1) fracture density (higher permeability), (2) alteration (high clay content), and (3) temperatures (higher dissolved solid content of ground water) within the bedrock low explain its presence.

11731 (IDO—1601-T1) **Regional gravity and aeromagnetic surveys of the Mineral Mountains and vicinity, Millard and Beaver Counties, Utah.** Carter, J.A.; Cook, K.L. (Utah Univ., Salt Lake City (USA). Dept. of Geology and Geophysics). Apr 1978. Contract EY-76-S-07-1601. 193p. Dep. NTIS, PC A09/MF A01.

The results of gravity and aeromagnetic surveys of the Mineral Mountains and vicinity are presented as a terrain-corrected Bouguer gravity anomaly map (about 1450 stations with 1-mgal contour interval) and a total magnetic field intensity residual anomaly map (with contour interval 50 gammas), respectively. Combined interpretation of the gravity and aeromagnetic data was conducted based on comparing and contrasting various processed maps and interpretative geologic cross sections produced from each survey. (MHR)

11732 (IDO—1601-T16) **Gravity and ground magnetic surveys in the Monroe and Joseph KGRA's and surrounding region, South Central Utah.** Halliday, M.E.; Cook, K.L. (Utah Univ., Salt Lake City (USA). Dept. of Geology and Geophysics). Jun 1978. Contract EY-76-S-07-1601. 183p. Dep. NTIS, PC A09/MF A01.

Thesis.

Regional gravity data were collected in portions of the Pavant Range, Tushar Mountains, northern Sevier Plateau, the Antelope Range, and throughout Sevier Valley approximately between the towns of Richfield and Junction, Utah. Additionally, detailed gravity and ground magnetic data were collected in the vicinity of hot springs in both the Monroe and Joseph Know. Geothermal Resource Areas (KGRA's) and subsurface geologic models were constructed. The regional gravity data were terrain

corrected out to a distance of 167 km from the station and 948 gravity station values were compiled into a complete Bouguer gravity anomaly map of the survey area. This map shows a strong correlation with most structural features mapped in the survey area. Four regional gravity profiles were modeled using two-dimensional formerd and inverse algorithms.

11733 (NATO/CCMS—60, pp 17-22) **Geothermal direct use potential in the eastern United States.** Salisbury, J. Jul 1978.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

The possibility of heat sources in eastern US granites and the gravity surveys done to determine geothermal gradients there are discussed briefly. (MHR)

GEOCHEMICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 11717

11734 (IDO—78-1701.b.3.3) **Initial investigation of soil mercury geochemistry as an aid to drill site selection in geothermal systems.** Capuano, R.M.; Bamford, R.W. (Utah Univ., Salt Lake City (USA). Research Inst.). Dec 1978. Contract EG-78-C-07-1701. 41p. Dep. NTIS, PC A03/MF A01.

A mercury-in-soil survey was conducted at the Roosevelt Hot Springs Known Geothermal Resource Area (KGRA), Utah, to evaluate mercury soil geochemistry as a method of selecting exploration well sites in a hot-water geothermal system. Samples of -80 mesh soil were collected at 30.5 m intervals along traverses crossing known structures, surficial geothermal alteration, and exploration well sites, and were analyzed using a Gold Film Mercury Detector. Strong mercury anomalies occur at locations along known structures in close proximity to subsurface thermal activity; examples include areas over hot spring deposits and near a shallow producing well. In contrast, background mercury concentrations are present in nearby locations with little or no indication of subsurface thermal activity, such as areas around deep marginal producing wells and dry wells, and areas lacking hot spring deposits. These results indicate that mercury geochemical surveys can be useful for identifying and mapping structures controlling fluid flow in geothermal systems and for delineating areas overlying near-surface thermal activity. Soil mercury geochemistry thus provides information which may aid in the cost-effective selection of exploratory well sites.

EXPLORATORY DRILLING AND WELL LOGGING

REFER ALSO TO CITATION(S) 11719, 11730, 11791

11735 (DOE/ET/15391—T2) **Fracture characterization study.** Kehrman, R.F. (Westinghouse Electric Corp., Boulder, CO (USA)). Apr 1978. Contract AC04-76ET15391. 28p. Dep. NTIS, PC A03/MF A01.

First, the origin, nature, and significance of fractures in general are discussed. Next, discussions are directed toward the designation and classification of fractures. Some typical fracture measurement techniques are discussed. Finally, geothermal fracture systems are investigated and correlations made to determine which fracture technologies from oil field work are applicable to geothermal systems. (MHR)

11736 (HIG—78-9) **Analysis of geophysical logs from the Hawaii geothermal project well.** Rudman, A.J. (Indiana Univ., Bloomington (USA)). Sep 1978. Contract EY-76-C-03-1093. 29p. Dep. NTIS, PC A03/MF A01.

A 6445-foot test well was completed on April 27, 1976 in the Puna Area of Hawaii as part of an extensive project to investigate a geothermal reservoir for energy production. Because bottom hole temperatures exceeded 300°C, it was possible to run geophysical logs in the upper 3500 feet only. Study of conventional and induction resistivity, self potential, neutron, gamma ray, caliper, temperature, temperature differential and drilling rate logs show that porosity, permeability and fluid flow are qualitatively identified on the logs. Lithologic logs of sample cuttings taken at five- to ten-foot intervals (together with cores taken at approximately 700-foot intervals) substantiate preliminary findings of the porous and permeable zones. Although the logs investigated are above many of the zones of production, new information was obtained about the in-situ nature of permeability in Hawaiian basalts.

11737 (IDO—78-1701.b.4.2) **Geological and geophysical analysis of Coso Geothermal Exploration Hole No. 1 (CGEH-1), Coso Hot Springs KGRA, California.** Galbraith, R.M. (Utah Univ., Salt Lake City (USA). Research Inst.). May 1978. Contract EG-78-C-07-1701. 50p. Dep. NTIS, PC A03/MF A01.

The Coso Geothermal Exploration Hole number one (CGEH-1) was drilled in the Coso Hot Springs KGRA, California, from September 2 to December 2, 1977. Chip samples were collected at ten foot intervals and extensive geophysical logging surveys were conducted to document the geologic character of the geothermal system as penetrated by CGEH-1. The major rock units encountered include a mafic metamorphic sequence and a leucogranite which intruded the metamorphic rocks. Only weak hydrothermal alteration was noted in these rocks. Drillhole surveys and drilling rate data indicate that the geothermal system is structurally controlled and that the drillhole itself was strongly influenced by structural zones. Water chemistry indicates that this geothermal resource is a hot-water rather than a vapor-dominated system. Several geophysical logs were employed to characcterize the drillhole geology. The natural gamma and neutron porosity logs indicate gross rock type and the accoustic logs indicate fractured rock and potentially permeable zones. A series of temperature logs run as a function of time during and after the completion of drilling were most useful in delineating the zones of maximum heat flux. Convective heat flow and temperatures greater than 350°F appear to occur only along an open fracture system encountered between depths of 1850 and 2775 feet. Temperature logs indicate a negative thermal gradient below 3000 feet.

11738 (SAN—1315-1) **Improved geothermal well logging tools using no downhole electronics. Final report.** Kratz, H.R.; Day, E.A.; Ginn, W.G. (Systems, Science and Software, La Jolla, CA (USA)). Jul 1979. Contract EY-76-C-03-1315. 74p. Dep. NTIS, PC A04/MF A01.

A geothermal sonde for measuring temperature and pressure using no downhole electronics was designed and tested for operation at temperatures up to 275°C (527°F) and pressures of at least 10,000 psi. The measurement system uses variable resistance transducers which are powered in series by an uphole constant current supply. The output signals from the transducers are measured with a digital voltmeter having very high common mode and normal mode rejection ratios. The high rejection ratios of the digital voltmeter virtually eliminate any noise or pickup introduced into the measurement system. The system was tested in a hydroclave at temperatures up to 288°C (550°F) and at pressure up to 8,000 psi. The sonde was also tested in the Los Alamos geothermal well at temperatures up to 186°C (366°F) and pressures up to 4100 psi. The main problems encountered were associated with pressure transducers and the logging cable or the cable head and connector. The results of this project indicate that this is a feasible method of making geothermal measurements without the use of downhole electronics and that with further development the technique could be extended to higher temperatures and pressures.

11739 (SAN—1325-T1) **Development of improved gaskets, sealants and cables for use in geothermal well logging equipment. Final summary report.** Schwartz, S.; Basiulis, D.; Leyden, R.; Landis, A. (Hughes Aircraft Co., Culver City, CA (USA)). Oct 1978. Contract EG-77-C-03-1325. 58p. Dep. NTIS, PC A04/MF A01.

The inventigation of materials which could be used for fabricating elastomeric seals for geothermal well logging equipment is described. The seals were to be made either from a methylphenylcarborane-siloxane base gum stock, or from new fluoroelastomer compounds synthesized at Hughes Aircraft Company. A literature search was made to obtain data on carborane-siloxane polymers, synthesis routes for fluorinated elastomers and high temperature hydrolytic stability tests of elastomers. Information was obtained on the first two topics, but very little was available on hydrolysis testing. A number of compounds, based on carborane-siloxane, were formulated and cured. Compression set, hardness and shrinkage tests with postcure variations were made on the most promising formulations. A simple hydrolytic stability test at 275°C (525°F) and 830 psi was developed which indicated that both the carborane and siloxane bonds were easily broken after short exposure periods. Thermodynamic calculatons indicated that this result could be expected. Because of the agreement between empirical and theoretical data, work on the carborane-siloxanes was discontinued after approximately the first year. Synthesis efforts to produce a highly fluorinated elastomer based on perfluorolkylene oxide were continued through the entrie program. None of these routes produced a satisfactory elastomer.

11740 (SAND—79-2271A) **Quartz resonator pressure transducer for geothermal well logging.** EerNisse, E.P.; McConnell, T.D. (Quartex, Inc., Salt Lake City, UT (USA); Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 5p. Dep. NTIS, PC A02/MF A01.

The development of a quartz resonator pressure transducer for geothermal well logging applications at up to 275°C and pressure up to 52 MPa is described briefly. (MHR)

11741 (SAND—79-2272A) **Monoconductor cables and cableheads.** Coquat, J.A. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 2p. Dep. NTIS, PC A02/MF A01.

A reliable, low noise interconnect system is needed between the up-hole electronics (cool) and the down-hole (hot) electronics. A project to develop such a single conductor base interconnect system

is discussed including successes to date, on-going work, and plans for the near future. (MHR)

11742 (SAND—79-2274A) **Upgrading mechanical tools: survey clocks.** Major, B.H. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 3p. Dep. NTIS, PC A02/MF A01.

Results of testing on survey clocks are reported and recommendations for upgrading them are listed. Each of the clocks were field tested after modification and some seals leaked. (MHR)

11743 **Geothermal well log interpretation. Progress report.** Denver, CO; Scientific Software Corporation (1978). 77p. (NP—24234).

Progress is presented on the following tasks: review of the state-of-the-art, classification of geothermal reservoir types, data acquisition, problem definition and directions for solution, and refinement of existing interpretation techniques and development of new ones. Computerized literature searches were conducted. The classification system defines five major characteristics which will qualify a potential reservoir. A catalog lists well logs currently available for study. Rock and fluid parameters needed for reservoir studies are listed. A list of matrix characteristics for rocks and minerals is given. (MHR)

LEGAL AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 11713, 12053

11744 (DOE/ID/12013—1) **Wyoming geothermal commercialization planning. Semi-annual progress report, January 1, 1979-June 30, 1979.** James, R.W. (Wyoming Univ., Laramie (USA)). 1979. Contract FC07-79ID12013. 45p. Dep. NTIS, PC A03/MF A01.

The objectives, project tasks, and specific task descriptions and products are reviewed. The resource assessment data for the state is not available and the planning activity is based on speculation at this date. (MHR)

11745 (DOE/ID/12014—1) **Montana geothermal commercialization planning. Semi-annual progress report, January 1, 1979-June 30, 1979.** Birkby, J.; Brown, K.; Chapman, M. (Montana Dept. of Natural Resources and Conservation, Helena (USA)). 1979. Contract FC07-79ID12014. 82p. Dep. NTIS, PC A05/MF A01.

Area development plans were prepared which describe geothermal resources and their potential use on a county or multicounty basis. Development plans for two areas are presented. Cost analyses show that the proximity of the geothermal resource to the end user is the most important criterion in geothermal energy development. Thirteen tentative site-specific plans are being revised. The analysis of institutional factors affecting geothermal development, the outreach, and the state geothermal are discussed briefly. (MHR)

11746 (DOE/ID/12015—1) **Arizona geothermal commercialization planning. Semi-annual progress report, January 1, 1979-June 30, 1979.** Hahman, R. Sr.; White, D.; Goldstone, L.; Mancini, F.; Chehab, M.; Weibel, B. (Arizona Solar Energy Research Commission, Phoenix (USA)). 1979. Contract FC07-79ID12015. 96p. Dep. NTIS, PC A05/MF A01.

The major projects undertaken include: the provision of a State Institutional Handbook, the provision of in-depth geothermal resource data, the comparison of energy sources and uses, economic data compilation for area development plans, the preparation of site-specific development plans, and the outreach program. Progress is reported on each of these projects. (MHR)

11747 (DOE/ID/12018—1) **Colorado geothermal commercialization planning. Semi-annual progress report, January 1, 1979-June 30, 1979.** Coe, B.A. (Colorado Geological Survey, Denver (USA)). 1979. Contract FC07-79ID12018. 95p. Dep. NTIS, PC A05/MF A01.

The potential for developing the geothermal resources of Colorado is detailed. Constraints that are limiting geothermal energy development are described. Area development plans, an institutional analysis, and the outreach program are presented. (MHR)

11748 (DOE/TIC—10280) **Transcript of proceedings of a public hearing on August 16, 1979 in Albuquerque, New Mexico, on the draft environmental impact statement, Geothermal Demonstration Program, Baca Ranch, Sandoval, and Rio Arriba Counties, New Mexico, before the All Indian Pueblo Council.** (All Indian Pueblo Council, Inc., Albuquerque, NM (USA)). 1979. 136p. Dep. NTIS, PC A07/MF A01.

To show that geothermal energy can contribute to the nation's energy supplies, development of a 50-megawatt geothermal project located in Redondo Creek Canyon on the Baca Ranch is planned. It is funded by DOE, Union Oil Company, and Public Service Company of New Mexico. The project is intended to stimulate industrial development by showing that geothermal development can be profitable, that it can be environmentally responsible, and that it can be socially acceptable. The public hearing deliberates the impacts from water usage, transportation, pollution, housing, production or generation of electricity, economics, and many other important aspects. Secondary factors such as employment, training, infringement of religious areas, transmission lines, archaeological sites, and subsidence are equally important. Statements were heard from government and industry representatives and testimony was heard from Pueblo representatives. (MCW)

11749 (DOE/TIC—10287) **Transcript of proceedings of a public hearing on August 30, 1979 in Albuquerque, New Mexico, on the environmental impact statement, Geothermal Demonstration Program.** (All Indian Pueblo Council, Inc., Albuquerque, NM (USA)). 1979. 289p. Dep. NTIS, PC A13/MF A01.

Portions of document are illegible.

Hearings on the Geothermal Demonstration Program for the 50-megawatt electrical power plant on the Baca Ranch in the Jemez Mountains is presented. DOE, the Union Oil Company, and Public Service Company of New Mexico are sponsoring the project. Union has been drilling and testing wells in this area since 1971 and evidence shows a geothermal reservoir capable of supporting 400 MW(e). Union will drill the producing wells and provide steam to the power plant. Public Service will buy the electricity-generating power plant and the transmission lines to take the power to market. The wells and construction are scheduled to be completed by March of 1982 and the demonstration project is to be completed in March 1987. This draft environmental statement represents the best information available on the potential impacts of the geothermal development on the Baca Ranch. Persons interested in the impacts of the project posed questions and members of a technical panel provided replies at the public hearing. (MCW)

11750 (UCRL—83666) **Land-use conflicts in The Geysers-Calistoga KGRA: a preliminary study.** O'Banion, K.; Hall, C.; Haven, K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Dec 1979. Contract W-7405-ENG-48. 67p. Dep. NTIS, PC A04/MF A01.

This preliminary study of potential land use conflicts of geothermal development in The Geysers region, one component of the LLL/LBL socioeconomic program, focuses on Lake County because it has most of the undeveloped resource and the least regulatory capability. The land resource is characterized in terms of its ecological, hydrological, agricultural, and recreational value; intrinsic natural hazards; and the adequacy of roads and utility systems and each factor is depicted on a map. Then those factors are analyzed for potential conflicts with both geothermal and urban development and the conflicts displayed on respective maps. A brief review of laws and methods germane to geothermal land-use regulation is included.

ECONOMIC AND FINANCIAL ASPECTS

11751 (NATO/CCMS—66, pp 203-212) **Economic feasibility model for evaluation of the uses of geothermal energy.** Larson, T. (Univ. of California, Riverside). Jul 1978.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

The purpose of this presentation is to familiarize representatives of the geothermal industries with a simple-to-use user-oriented economic feasibility model that has been developed at the University of California, Riverside. In the past year and a half research has been conducted at UCR to determine the effects of geothermal energy in Imperial County, California. The research was multidisciplinary covering geological, engineering, geographical, economic, social, and political aspects of geothermal development.

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

REFER ALSO TO CITATION(S) 11725, 11765, 11766, 11767, 11777, 11779

11752 (COO—2730-3(Vol.1)) **Control of hydrogen sulfide emission from geothermal power plants. Volume I. Summary of results. Final report.** Brown, F.C.; Harvey, W.W.; Warren, R.B. (EIC Corp., Newton, MA (USA)). 1979. Contract EY-76-C-02-2730. 76p. Dep. NTIS, PC A05/MF A01.

A program of laboratory and pilot plant tests, detailed process and project engineering work, and process engineering and economic evaluation studies has been carried out in support of the design of a test facility for demonstration of the copper sulfate process for the removal of hydrogen sulfide from geothermal steam at turbine upstream conditions. A demonstration plant has been designed which is capable of removing 99% of the H_2S, 90% of the NH_3, and

significant amounts of H_3BO_3 and particulates from 100,000 lb/hr of geothermal steam of The Geysers composition. Criteria for the mechanical and process design of the scrubber have been confirmed in field tests of fifty hours duration on an eight-inch diameter scrubber at PG & E's Unit No. 7, The Geysers. The background of the problem and the technical approach to its solution, the scope and results of the first-phase laboratory testing, the scope and results of the experimental and analytical studies carried out in the second phase, and a description of the configuration of the demonstration plant and the test plan for its operation are summarized. (MHR)

11753 (COO—2730-3(Vol.2)) **Control of hydrogen sulfide emission from geothermal power plants. Volume II. Laboratory results and process engineering evaluation. Final report.** Brown, F.C.; Harvey, W.W.; Warren, R.B. (EIC Corp., Newton, MA (USA)). 1979. Contract EY-76-C-02-2730. 388p. Dep. NTIS, PC A17/MF A01.

Reports on ten different tasks are included. Separate abstracts were prepared for each one. (MHR)

11754 (COO—2730-3(Vol.2), pp 41-87) **Leach regeneration tests.** 1979.

In Control of hydrogen sulfide emission from geothermal power plants. Volume II. Laboratory results and process engineering evaluations. Final report.

Pressure leach experiments were carried out on copper sulfide solids produced in the laboratory scrubber and produced during operation of the 8-inch field-test scrubber at The Geysers. Precipitates produced by scrubbing H_2S from synthetic geothermal steam were typically more reactive toward oxygen pressure leaching in acid medium than are synthetic or mineral CuS powders. In the case of scrubber solids, the preponderant reaction product of sulfide oxidation under the conditions investigated was sulfate rather than elemental sulfur. Under conditions of vigorous gas dispersal in the solution, the most important parameter determining leach rates was oxygen partial pressure. At a temperature of 115°C, essentially complete reaction could be achieved in about 2 hrs when the oxygen partial pressure was maintained at $\geq$ 75 psi. These are relatively mild process conditions and confirm the suitability of pressure leach regeneration for small H_2S removal plants. (MHR)

11755 (COO—2730-3(Vol.2), pp 89-115) **Filter leaf test studies.** 1979.

In Control of hydrogen sulfide emission from geothermal power plants. Volume II. Laboratory results and process engineering evaluations. Final report.

Copper sulfide solids produced by removing low concentrations of hydrogen sulfide from steam by scrubbing with copper sulfate, while composed ultimately of particles of the order of 1 micron, flocculate naturally and settle and filter rapidly. There are no apparent differences in macroscopic properties between material produced in laboratory tests scrubbing simulated geothermal steams and solids produced during field tests on actual geothermal steams. The solids content of filter cakes produced and pulp densities from settled slurries tend to be rather low, 25 and 15% solids, respectively, due to the floccy nature of the solids produced. Tight, monofilament filter cloths show excessive tendencies to blind while multifilament cloths require periodic back washing. Spun fabrics show little tendency to blind and give adequate cake release.

11756 (COO—2730-3(Vol.2), pp 117-152) **Analytical technique development.** 1979.

In Control of hydrogen sulfide emission from geothermal power plants. Volume II. Laboratory results and process engineering evaluations. Final report.

Laboratory testing on simulated purge streams and on purge slurry returned from operation of the 8" scrubber on geothermal steam have demonstrated that on-line monitoring of pH and monitoring and control of copper content are feasible in this process. A Swirlklean by-pass filter will remove precipitated sulfide solids from the sample purge stream very effectively. A minimum amount of back-flushing - once per day - will maintain high filtration rates. A Teledyne photometric analyzer is effective, stable, and accurate in measuring the copper content of a filtered purge stream in the presence of ammonium sulfate and sulfuric acid, and will generate an output signal which can be used for process control to maintain the desired copper content. The absorbance of the purge solution is a strong function of temperature, as well as of concentration, so that sample temperature control or a calibration for temperature will be required to obtain precise concentrations. A Great Lakes Analyzer with a differential electrode can serve to monitor the pH of the purge stream. However, modification of the standard probe by replacing the internal pH reference solution with one more suitable for this system is required to obtain linearity of response in the range pH 1 to 2. Periodic recalibrations will probably also be required to maintain accuracy within +- 0.1 pH unit. Both instruments will have to be modified for field use.

11757 (COO—2730-3(Vol.2), pp 195-247) **Roast regeneration studies.** 1979.

In Control of hydrogen sulfide emission from geothermal power plants. Volume II. Laboratory results and process engineering evaluations. Final report.

Laboratory work was carried out to characterize the broad technical features of the roast-regeneration of copper sulfide scrubber solids. Both wet and dry roasting give oxidation products which are soluble in sulfuric acid to form a copper sulfate solution suitable for makeup to the scrubber. Partial acid neutralization for the overall hydrogen sulfide removal process can be effected by dissolving the roasted solids in scrub solution. Wet roasting, whereby a thin bed of solids is moistened while being heated in air, can be made reasonably rapid, i.e., reaction times in the range 3 to 6 hr, at temperatures above about 150°C. However, the reaction is much slower if water, rather than acid, is used for moistening. Dry roasting was studied with thin fixed beds at temperatures of 200, 250, and 300°C. (MHR)

11758 (COO—2730-3(Vol.2), pp 249-265) **Liquid-solid separation studies.** 1979.

In Control of hydrogen sulfide emission from geothermal power plants. Volume II. Laboratory results and process engineering evaluations. Final report.

Liquid solid separation rates of copper sulfide solids, produced by removing low concentrations of hydrogen sulfide from steam by scrubbing with copper sulfate, were measured in a continuous laboratory scale decanter and in a laboratory batch centrifuge. Tests were carried out on solids with liter cylinder settling rates which varied by more than an order of magnitude. The continuous decantation tests confirmed the preliminary design criteria used for the decanter for the 100,000 lb/hr demonstration facility. In addition, it is indicated that stable operation is possible over a wide range of total flow rates, percents decanted, and feed solids contents. Batch centrifugation tests showed that the solids settled rapidly and to approximately 50% solids density at 1600g. At a commercial scale of operation, 50 mW or 10^6 lb/hr steam containing 220 ppM H_2S, a continuous decanter is the preferred type of liquid solid separation device when regeneration of copper sulfate is to be carried out by leaching. For regeneration by roasting, where much higher degrees of water removal are required, a centrifuge would be used. (MHR)

11759 (EGG—2005) **Effects of irrigation on crops and soils with Raft River geothermal water.** Stanley, N.E.; Schmitt, R.C. (Idaho National Engineering Lab., Idaho Falls (USA)). Jan 1980. Contract EY-76-C-07-1570. 30p. Dep. NTIS, PC A03/MF A01.

The Raft River Irrigation Experiment investigated the suitability of using energy-expended geothermal water for irrigation of selected field-grown crops. Crop and soil behavior on plots sprinkled or surface irrigated with geothermal water was compared to crop and soil behavior on plots receiving water from shallow irrigation wells and the Raft River. In addition, selected crops were produced, using both geothermal irrigation water and special management techniques. Crops irrigated with geothermal water exhibited growth rates, yields, and nutritional values similar to comparison crops. Cereal grains and surface-irrigated forage crops did not exhibit elevated fluoride levels or accumulations of heavy metals. However, forage crops sprinkled with geothermal water did accumulate fluorides, and leaching experiments indicate that new soils receiving geothermal water may experience increased salinity, exchangeable sodium, and decreased permeability. Soil productivity may be maintained by leaching irrigations.

11760 (UCID—18293) **Geothermal Aquatic Ecosystem Program: Geyser-Calistoga KGRA. Interim report .** Ireland, R.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Oct 1979. Contract W-7405-ENG-48. 13p. Dep. NTIS, PC A02/MF A01.

The formulation of a study plan for assessing the impact of geothermal development in the Geysers-Calistoga KGRA upon the local aquatic ecosystem is described briefly. A program for chemically characterizing the various partitions of the streambed sediment is described. Current activities and cooperative efforts are mentioned. (MHR)

11761 (UCRL—52783) **Geothermal environmental projects publication list with abstracts 1975-1978.** Ricker, Y.E.; Anspaugh, L.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 May 1979. Contract W-7405-ENG-48. 91p. Dep. NTIS, PC A05/MF A01.

This report contains 119 abstracts of publication resulting from or closely related to geothermal environmental projects conducted by the Environmental Sciences Division at Lawrence Livermore Laboratory. Publications are listed chronologically from 1975 through 1978. The main entries are numbered sequentially, and include the full citation, an abstract, and selected keywords. This section is followed by an author index, and a keyword index.

GEOTHERMAL POWER PLANTS

11762 (EPRI-EA—630) **Economic modeling of electricity production from hot dry rock geothermal reservoirs: methodology and analyses. Final report.** Cummings, R.G.; Morris, G.E. (New Mexico Univ., Albuquerque (USA). Dept. of Economics). Sep 1979. Contract W-7405-ENG-36. 90p. (LA—7888-HDR). Dep. NTIS, PC A05/MF A01.

An analytical methodology is developed for assessing alternative modes of generating electricity from hot dry rock (HDR) geothermal energy sources. The methodology is used in sensitivity analyses to explore relative system economics. The methodology used a computerized, intertemporal optimization model to determine the profit-maximizing design and management of a unified HDR electric power plant with a given set of geologic, engineering, and financial conditions. By iterating this model on price, a levelized busbar cost of electricity is established. By varying the conditions of development, the sensitivity of both optimal management and busbar cost to these conditions are explored. A plausible set of reference case parameters is established at the outset of the sensitivity analyses. This reference case links a multiple-fracture reservoir system to an organic, binary-fluid conversion cycle. A levelized busbar cost of 43.2 mills/kWh ($1978) was determined for the reference case, which had an assumed geothermal gradient of 40°C/km, a design well-flow rate of 75 kg/s, an effective heat transfer area per pair of wells of 1.7×10^6 m², and plant design temperature of 160°C. Variations in the presumed geothermal gradient, size of the reservoir, drilling costs, real rates of return, and other system parameters yield minimum busbar costs between -40% and +76% of the reference case busbar cost.

11763 (NATO/CCMS—66, pp 173-178) **Economic feasibility of utilizing geothermal heat for an agricultural chemical plant.** Sherwood, P.B.; Johnson, W.E. (WESTEC Services, Inc., San Diego, CA). Jul 1978.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

The engineering and economic feasibility of utilizing geothermal heat from the Heber KGRA for industrial processing purposes at the Valley Nitrogen Producers, Inc. El Centro, California agricultural chemical plant is being investigated. Brine production costs as well as capital costs of geothermal binary and flash steam plants have been estimated utilizing a modified Battelle, Pacific Northwest Laboratories' GEOCOST program. Fossil fuel costs, geothermal brine costs, and the rate of inflation have been projected through 1997. Using these data, the internal rate of return, as a function of the amount of fossil fuel displaced by geothermal energy, has been calculated and preliminary conclusions drawn.

11764 (SAN—0389-T1) **Industry survey of the need for a Federal grant-assisted geothermal demonstration power plant. Final report.** (Geothermal Resources Council, Davis, CA (USA)). Jun 1978. Contract EW-78-X-03-0389. 37p. Dep. NTIS, PC A03/MF A01.

Findings are presented from two separate studies: a preliminary study of leaders of the geothermal industry and a second study of a ten percent representative sample of other firms. The studies are intended to determine if a need still exists for a federal grant-assisted geothermal demonstration power plant. The following are included: selection of the survey samples from the population comprising the geothermal industry; the development of the survey instrument; the collection and analysis of the results; and a summary. The responses of financial firms are discussed. (MHR)

DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 11753, 11754, 11755, 11756, 11757, 11758, 11777

11765 (COO—2730-3(Vol.2), pp 267-286) **Scrubber configuration studies.** 1979.

In Control of hydrogen sulfide emission from geothermal power plants. Volume II. Laboratory results and process engineering evaluations. Final report.

The performance of shower type trayed columns, a spray column, and a venturi have been evaluated in laboratory tests to determine their effectiveness as scrubbers for the removal of H_2S from geothermal steam. All are possible alternatives to the use of a crossflow sieve tray scrubber in this service. It ws found that all devices tested were acceptable from an operability point of view: they did not foul or retain solids and had wide ranges of stable operation. However, while it proved to be relatively easy to obtain H_2S removal efficiencies in the 80 to 90% range, near quantitative removal was not achieved under any conditions tested.

11766 (COO—2730-3(Vol.2), pp 287-317) **Eight inch column design and operation.** 1979.

In Control of hydrogen sulfide emission from geothermal power plants. Volume II. Laboratory results and process engineering evaluations. Final report.

Nearly quantitative removal (cleaned steam < 0.7 ppM H_2S) of hydrogen sulfide from geothermal steam has been obtained, with no major operating problems, by scrubbing with copper sulfate solution in an 8" scrubbing column containing a single counter-flow sieve tray. In a run of thirty hours duration, an average removal efficiency of 98.9% was obtained (cleaned steam average H_2S content 2.6 ppM) at a pressure drop of 0.5 psi. The scrub solution averaged about 3 g/l Cu, 60 g/l $(NH_4)_2SO_4$, 15 g/l H_2SO_4 and had a pH (room temperature) of 1.4. No fouling of the scrubber internals due to deposition of solids or accumulation of large agglomerates was observed. Entrainnment of copper from the scrub solution into the cleaned steam was negligible, being below the limit of detection (< 0.05 ppM). Approximately 80% of the ammonia and boron in the incoming steam were also removed under the process conditions tested. The copper sulfide solids produced had essentially the same macroscopic properties as those made in lab-scale tests on simulated geothermal steam and settled rapidly. The main material of construction for the scrubber, C20Cb3, showed excellent service under operating conditions. being superior to types 304 and 316 stainless steel but not as passive as titanium (MHR)

11767 (COO—2730-3(Vol.2), pp 319-384) **Optimization and economics studies.** 1979.

In Control of hydrogen sulfide emission from geothermal power plants. Volume II. Laboratory results and process engineering evaluations. Final report.

A process engineering and economic evaluation has been carried out to determine the optimum configuration for the copper sulfate process at a commercial scale and the effect of varying steam compositions and treatment rates on process economics. A trayed scrubber with a single crossflow sieve tray is the most cost effective type of device if high degrees of H_2S removal are required. Regeneration by oxygen pressure leaching is less costly than roast regeneration, at least for plant sizes of 110 MW or less, so that liquid-solid separation is most advantageously carried out by continuous decantation. The overall process material and energy balance is a function of the amount of steam to be treated, its composition, and the stoichiometry of the scrubbing and regeneration reactions. Capital costs for a commercial scale plant have been estimated by a factory technique. (MHR)

11768 (LA—7664-C, pp 32-41) **Effect of scaling on geothermal power plant design and economics.** Hankin, J.W. (Bechtel National, Inc., San Francisco, CA). Apr 1979.

From Workshop on scale control in geothermal energy extraction systems; Los Alamos, NM, USA (6 Oct 1977).

A conceptual design study of a geothermal power plant is summarized. Possible reasons for selecting a specific energy conversion process are described depending upon the scaling characteristic of the geothermal brine at a particular site. A discussion of some general chemistry and scaling considerations that affect the design and economics of geothermal power plants is included.

11769 (SAN—1572-T2) **System design verification of a hybrid geothermal/coal fired power plant.** (Parsons (Ralph M.) Co., Pasadena, CA (USA)). Sep 1978. Contract EG-77-G-03-1572. 222p. Dep. NTIS, PC A10/MF A01.

This hybrid plant utilizes geothermal fluid for feedwater heating. With respect to the extraction of available work from the geothermal fluids, this cycle is approximately two times as efficient as the all geothermal plant. The System Design Verification Study presented verifies the technical and economic feasibility of the hybrid plant. This report is comprised of a conceptual design, cost estimate, and economic analysis of a one-unit 715 MW hybrid geothermal/coal fired power plant. In addition to the use of geothermal fluid for feedwater heating, its use is also investigated for additional power generation, condensate and cooling tower makeup water, coal beneficiation, air preheating, flue gas reheating and plant space heating requirements. An engineering and construction schedule for the hybrid plant is also included.

POWER PLANT SYSTEMS AND COMPONENTS

11770 (ORNL/SUB—79/13564/1) **Experimental testing of a direct contact heat exchanger for geothermal brine. Final report, July 1, 1978-February 1, 1979.** Urbanek, M.W. (Oak Ridge National Lab., TN (USA)). Dec 1979. Contract W-7405-ENG-48. 172p. (ORNL/SUB—79/45736/1). Dep. NTIS, PC A08/MF A01.

A series of direct contact heat exchanger (DCHX) experiments were conducted at the East Mesa Geothermal Test Site during the period July 1, 1978 to February 1, 1979. The purpose of these tests was to provide additional data necessary to better understand the thermal and hydraulic characteristics of the DCHX binary cycle loop components that may be used to extract energy from geothermal brines. Isobutane and Isopentane were tested as secondary working fluids. The analytical and experimental efforts were direct-

ed at the problems of working fluid loss in the effluent brine, carryover of water vapor with the vaporized secondary fluid and the free CO_2 content of the feed brine. The tests aimed at evaluating the heat transfer performance of various type tubes installed in vertical shell-and-tube secondary fluid condensers. Data was collected while operating a low temperature isopentane cycle with brine preflashed to 210 to 212°F; the objective being to gain insight to waste heat recovery applications such as the Arkansas Power and Light project. Possible alternatives for isobutane recovery from the spent brine were investigated. A system was designed and the economic aspects studied.

11771 (SAN—1572-T1) **High geothermal energy utilization geothermal/fossil hybrid power cycle: a preliminary investigation.** Grijalva, R.L.; Sanemitsu, S.K. (Burbank City Public Service Dept., CA (USA)). Nov 1978. Contract EG-77-G-03-1572. 107p. Dep. NTIS, PC A06/MF A01.

Combining geothermal and fossil fuel energy into the so-called hybrid cycle is compared with a state-of-the-art double-flash geothermal power cycle using resources which vary from 429°K (312°F) to 588°K (598°F). It is demonstrated that a hybrid plant can compete thermodynamically with the combined output from both a fossil-fired and a geothermal plant operating separately. Economic comparison of the hybrid and double-flash cycles is outlined, and results are presented that indicate the performance of marginal hydrothermal resources may be improved enough to compete with existing power cycles on a cost basis. It is also concluded that on a site-specific basis a hybrid cycle is capable of complementing double-flash cycles at large-capacity resources, and can operate in a cycling load mode at constant geothermal fluid flow rate.

GEOTHERMAL ENGINEERING

DRILLING TECHNOLOGY AND WELL HARDWARE

11772 (DOE/ET/28373—1(Pt.1)) **Atlantic Coastal Plain Geothermal Drilling Program: DOE/Crisfield Airport No. 1 well, Somerset County, Maryland. Part I. Drilling and completion. Final report.** Radford, L.; Cobb, L.B.; McCoy, R.L. (Gruy Federal, Inc., Houston, TX (USA)). Jan 1980. Contract ET-78-C-08-1558. 62p. Dep. NTIS, PC A04/MF A01.

The Department of Energy Crisfield Airport No. 1 well was the first deep well drilled to evaluate the geothermal potential of the Atlantic Coastal Plain. The well was spudded on May 13, 1979, and reached a total depth of 5562 feet on June 14, 1979. A 16-inch OD string of conductor casing was set at 165 feet and cemented to the surface. Surface casing of 10-3/4 inch OD was set at 1715 feet and cemented to the surface, and a 7-5/8 inch OD production string was set at 4625 feet. During drilling operations 13 cores were taken covering a total of 331 feet; 211 feet (64 percent) of core material was recovered. A full suite of open- and cased-hole logs was run over the entire section.

11773 (SAND—79-1360) **FY 79 Lava Lake Drilling Program: results of drilling experiments.** Neel, R.R.; Striker, R.P.; Curlee, R.M. (Sandia Labs., Albuquerque, NM (USA)). Dec 1979. Contract EY-76-C-04-0789. 172p. Dep. NTIS, PC A08/MF A01.

A drilling program was conducted in December 1978 and January and February 1979 to continue the characterization of the solid and liquid rock components of the Kilauea Iki lava lake. Six holes were drilled from the surface and two previously drilled holes were reentered and deepened for the purposes of measuring downhole temperature profiles, recovering samples of solid, plastic, and molten rock, measuring crust permeability, and determining the performance of conventional and special drilling techniques. Conventional HQ-size (3.78 inches diameter) core drilling equipment using water for cooling and cuttings removal was used to successfully drill during initial entry into 1052°C formations. Conventional drilling in reentering flow-back rock was less reliable. The specially designed water jet-augmented drag bit or water jet-augmented core bit was needed to drill reliably into the plastic flow-back rock and through liquid rock veins. This document contains the drill performance data which were recorded during drilling in the crust and the plastic and molten rock zones using both conventional and special drilling procedures and equipment.

11774 (SAND—79-1499) **Geothermal drilling and completion technology development program. Semi-annual progress report, October 1978-March 1979.** Varnado, S.G. (ed.). (Sandia Labs., Albuquerque, NM (USA)). Sep 1979. Contract EY-76-C-04-0789. 104p. Dep. NTIS, PC A06/MF A01.

The progress, status, and results of ongoing Research and Development (R and D) within the Geothermal Drilling and Completion Technology Development Program are described. The program emphasizes the development of geothermal drill bits, drilling fluids, and completion technology. Advanced drilling systems are also under development. The goals of the program are to develop the technology required to reduce well costs by 25% by 1982 and by 50% by 1986.

11775 (SAND—79-1880C) **Drill stem steels for use in geothermal environments.** Salzbrenner, R. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 39p. (CONF-800204—1). Dep. NTIS, PC A03/MF A01.

From Energy-sources technology conference; New Orleans, LA, USA (3 Feb 1980).

Steels which are used in drill stem for conventional drilling have been selected primarily to satisfy certain static strength requirements and cost considerations. As the environments in which drilling is performed become more severe (e.g., in geothermal fluids) additional considerations must be given to the design of alloys which are resistant to general corrosion, stress corrosion, and corrosion fatigue. General design considerations for steel alloys which should provide an enhanced resistance to geothermal drilling operations are presented. These considerations include discussion of the chemistry and metallurgical substructure, and how their variation affects the mechanical and corrosion properties of steel used for drill stem applications. A duplex ferritic-martensitic steel has an advantageous combination of compositional and microstructural features which should lead to improved chemical resistance (particularly to hydrogen sulfide) as well as provide a good combination of strength and toughness properties. This duplex steel is based on the iron-2.0 weight percent silicon-0.1 weight percent carbon system, and offers the potential of enhanced performance in geothermal drilling as well as low alloy cost.

11776 (SAND—79-1905C) **Federal program in geothermal drilling and completion research and development.** Varnado, S.G. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 19p. (CONF-800204—2). Dep. NTIS, PC A02/MF A01.

From Energy-sources technology conference; New Orleans, LA, USA (3 Feb 1980).

The high cost of drilling and completing geothermal wells is an impediment to the development of this resource. The Department of Energy (DOE), Division of Geothermal Energy (DGE), is conducting an R and D program directed at reducing well costs through improvements in geothermal drilling and completion technology. This program includes R and D activities in high temperature drilling hardware, drilling fluids, lost circulation control methods, completion technology, and advanced drilling systems. Sandia Laboratories manages this program for DGE. This paper presents an overview of the program.

CORROSION, SCALING, AND MATERIALS DEVELOPMENT

REFER ALSO TO CITATION(S) 11757, 11766, 11768, 11775

11777 (COO—2730-3(Vol.2), pp 153-193) **Materials testing.** 1979.

In Control of hydrogen sulfide emission from geothermal power plants. Volume II. Laboratory results and process engineering evaluations. Final report.

A series of tests has been carried out to determine the resistance to corrosion and stability of various materials under conditions which simulate operation of process steps other than steam scrubbing. A variety of alloy materials, composites, and elastomers were selected for testing based on information on their suitability derived from the open literature and provided by manufacturers. Austenitic stainless steels were found to be suitable for use under all conditions tested at temperatures up to at least 125°C. Type 304 would be the preferred alloy in terms of cost and general availability. Elastomers such as Viton and EPR and fluorinated polymers such as Teflon will also provide excellent service up to the maximum temperatures recommended by the manufacturers. A series of weight gain and stress-deflection tests was carried out on two types of composite materials: fiberglass reinforced vinyl esters and chlorinated polyesters. An additional series of tests carried out in an attempt to determine the mechanisms important in the initiation of crevice corrosion was inconclusive. (MHR)

11778 (LA—7664-C) **Proceedings of workshop on scale control in geothermal energy extraction systems.** Feber, R.C. (ed.). (Los Alamos Scientific Lab., NM (USA)). Apr 1979. Contract W-7405-ENG-36. 128p. (CONF-7710207—). Dep. NTIS, PC A07/MF A01.

From Workshop on scale control in geothermal energy extraction systems; Los Alamos, NM, USA (6 Oct 1977).

Nine papers are included. Separate abstracts were prepared for eight and one was listed by title. Also included are the workshop recommendations for research needs. (MHR)

11779 (LA—7664-C, pp 1-31) **Fluid management engineering program for the Geothermal Energy Division, US Department of Energy.** Reeber, R.R. (Dept. of Energy, Washington, DC). Apr 1979.

From Workshop on scale control in geothermal energy extraction systems; Los Alamos, NM, USA (6 Oct 1977).

The author's views regarding approaches required to define and solve the fluid management needs of geothermal electric development are summarized. Some of the important production, corrosion and scaling, and disposal problems are reviewed. The need for subsurface safety valves is mentioned. (MHR)

11780 (LA—7664-C, pp 42-44) **Scale and solids control at the Salton Sea KGRA.** Owen, L.B.; Tardiff, G.E. (Lawrence Livermore Lab., CA). Apr 1979.

From Workshop on scale control in geothermal energy extraction systems; Los Alamos, NM, USA (6 Oct 1977).

The viability of energy conversion processes intended for electric power production at liquid-dominated geothermal resources can be jeopardized by severe scaling, corrosion, and suspended solids problems that arise as a consequence of the high chloride content and trace element composition of geothermal brine. For instance, the Salton Sea KGRA (SSKGRA) is the largest known high-temperature hydrothermal resource in this country, yet all previous attempts, dating back to the 1920's, to produce power economically at the field have been unsuccessful. In 1974, the Laboratory's Geothermal Program began to address the problems related to utilization of high-salinity geothermal resources. Initial emphasis was placed on solving the scale and solids problem since adequate control was recognized as a mandatory requirement for operation of a TOTAL FLOW turbine at the SSKGRA. Furthermore, a totally programmatic approach was adopted insofar as programmatic time frames did not allow for detailed laboratory investigations. A primary virtue of this philosophy was avoidance of the severe difficulties associated with exactly duplicating complex brine systems at elevated temperatures and pressures in the laboratory. Our strategy combined operation of field experimental loops with analysis of scale and solids formation rates, chemical compositions, microstructures, and thermochemistry, coupled with appropriate literature surveys in order to identify potentially effective control measures.

11781 (LA—7664-C, pp 54-55) **Silica precipitation and scaling in dynamic geothermal systems.** Bohlmann, E.G.; Shor, A.J.; Berlinski, P.; Mesmer, R.E. (Oak Ridge National Lab., TN). Apr 1979.

From Workshop on scale control in geothermal energy extraction systems; Los Alamos, NM, USA (6 Oct 1977).

An existing 100-gpm titanium loop was modified to provide a facility for studying the formation of silica precipitates, their properties and fates, as a function of brine composition, temperature, and flow conditions. Simulated silica saturated geothermal waters are prepared by circulating part of the loop flow (~ 1 gpm) through a bypass column filled with amorphous silica powder. A second ~ 1-gpm stream is circulated through a heat exchanger in which dynamic scaling studies are conducted. Design variables include overall ΔT to 125°C, linear flow rate of 3 to 7 fps, Reynolds number of 10^4 to 10^5. The heat exchanger was divided into five consecutive segments so successive temperature intervals could be instrumented to monitor changes in heat transfer characteristics; selective destructive examination when desired is also facilitated. Blind end flanges on each segment permit borescope examination of scales in situ and sampling access. The stream leaving the heat exchanger is reheated by an electrical reheat system to replace the 40-kW heat equivalent removed at maximum ΔT, and recycled. Five runs have been carried out in this system and the results are summarized.

11782 (LA—7664-C, pp 56-65) **Modeling of geothermal power systems.** Shannon, D.W. (Battelle, Pacific Northwest Laboratories, Richland, WA). Apr 1979.

From Workshop on scale control in geothermal energy extraction systems; Los Alamos, NM, USA (6 Oct 1977).

This program centers on the development of four computer codes: EQUILIB, an equilibrium chemistry code that takes a brine model and calculates what minerals would become insoluble and how much would precipitate with changed temperatures, pressures, and volumes in a power cycle; FLOSCAL, a code to estimate the build-up rate of scale on pipes and components; PLANT, an extensive thermohydraulics code that optimizes a typical multistage flash plant or binary cycle plant for a reservoir and then calculates plant degradation due to scale buildup; and GEOSCALE, a time-dependent code to combine the above codes to assess when and how the performance of a geothermal power plant will degrade with time as a result of scale buildup.

11783 (LA—7664-C, pp 66-72) **LASL's relationship to the modeling of geochemical systems.** Merson, T.J. (Los Alamos Scientific Lab., NM). Apr 1979.

From Workshop on scale control in geothermal energy extraction systems; Los Alamos, NM, USA (6 Oct 1977).

The basic relationship of LASL modeling and coordination tasks to the activities of other researchers is explored. The LASL contribution consists of studying design problems of specific components. The calculational approach used to model a specific component is outlined. (MHR)

11784 (LA—7664-C, pp 73-108) **Thermodynamics and kinetics of scale formation.** Eugster, H.P. (Johns Hopkins Univ., Baltimore, MD); Weare, J.H. Apr 1979.

From Workshop on scale control in geothermal energy extraction systems; Los Alamos, NM, USA (6 Oct 1977).

Available research results are reviewed and information needs are indicated on the following aspects of scale formation: scale characterization, mechanisms of scale formation, solubility data, solubilities calculated from thermodynamic data, solubility tests, kinetics of scale precipitation, precipitation kinetics, and precipitation and turbulent flow. (MHR)

11785 (SAND—79-1981) **Corrosion of some pure metals in basaltic lava and simulated magmatic gas at 1150°C.** Douglass, D.L.; Healey, J.T. (Sandia Labs., Albuquerque, NM (USA)). Dec 1979. Contract EY-76-C-04-0789. 77p. Dep. NTIS, PC A05/MF A01.

The work summarized was designed to provide an understanding of the reaction mechanisms and modes of degradation of various metals so that the best generic types of alloys can be selected for structural components and instrumentation. Fifteen pure metals were studied. These included base metals such as iron, nickel, and cobalt; some precious metals: platinum, rhodium and palladium (possible thermocouple or lead wire materials); refractory metals: tungsten, molybdenum, tantalum, niobium, vanadium, rhenium; plus other high melting metals such as titanium and zirconium. Samples were exposed to basaltic lava at 1150°C for periods of 24 and 96 hours. A cover gas was used to produce oxygen and sulfur fugacities corresponding to those of the gases dissolved in basaltic melts. The corrosion behavior is described. Extensive analyses of the reaction products by scanning electron microscopy, x-ray energy dispersive analysis, electron microprobe analysis, and metallography are presented for each metal. The products formed are discussed with reference to thermodynamic stability diagrams, and the reaction path concept is used to explain some of the corrosion product morphologies.

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

REFER ALSO TO CITATION(S) 11722

11786 (DOE/ET/28373—1(Pt.2)) **Atlantic Coastal Plain Geothermal Drilling Program: DOE/Crisfield Airport No. 1 well, Somerset County, Maryland. Part II. Well test analysis. Final report.** Hartsock, J.H.; McCoy, R.L.; Radford, L. (Gruy Federal, Inc., Houston, TX (USA)). Jan 1980. Contract ET-78-C-08-1558. 168p. Dep. NTIS, PC A08/MF A01.

Crisfield Airport No. 1 well was drilled and completed as the first deep test of the Atlantic Coastal Plains Geothermal Program. The well penetrated several thick, unconsolidated sands, three of which were selected for short-term testing. Bottomhole pressures during pumping and recovery were measured using a surface-recording quartz crystal gauge accurate to 0.01 psi. At the surface a data collection station was assembled to measure the flowing temperature, detect sand production, monitor scale deposition, and sample the effluent. The results of these tests are shown. The maximum surface temperature recorded during pumping operations was 127°F (52.8°C). Chemical analysis of the water samples from the zones showed total dissolved solids of approximately 71,500 parts per million.

11787 (LA—8197-MS) **Pressure losses at the transition from radial flow within fractures to longitudinal flow within production wells.** Murphy, H.; Pearce, R. (Los Alamos Scientific Lab., NM (USA)). Jan 1980. Contract W-7405-ENG-36. 22p. Dep. NTIS, PC A02/MF A01.

Improved energy production from many types of energy reservoirs requires a better understanding of the fluid mechanics in the vicinity of the fracture-wellbore intersection. Typically, the aperture (smallest dimension) of a hydraulic fracture is only of the order of 1 mm (0.04 in) so that reasonable energy production rates from geothermal systems require fairly large flow velocities within the fractures, which often result in non-Darcian flow. Near the production well at several well diameters away, the flow within the fracture is predominantly radial; however, as the immediate intersection with the well is approached, a significant component of momentum is directed in the longitudinal, or wellbore, direction. However, since radial momentum still increases with decreasing radius, the flow at the turn into the production well forms a vena contracta. Downstream of this vena contracta the flow expands to fill the entire well diameter. This expansion results in a reduction of longitudinal momentum accompanied by an adverse pressure gradient, i.e., one in which pressure increases in the flow direction. The adverse pressure gradient results in flow separation, enhanced turbulence, and large pressure losses. These flow phenomena were investigated experimentally for the simple case where the fracture plane and the wellbore drilling axis are orthogonal. Measurements included the pressure loss associated with the transition from radial fracture flow to longitudinal wellbore flow, the flow area constriction represented by the vena

contracta, and the downstream distances where attachment, and then fully developed wellbore flow, began.

11788 (SAN—1093-T8) **Hawaii Geothermal Project.** Yuen, P.C.; Chen, B.H.; Kihara, D.H.; Seki, A.S.; Takahashi, P.K. (Hawaii Univ., Honolulu (USA)). Sep 1978. Contract EY-76-C-03-1093. 114p. Dep. NTIS, PC A06/MF A01.

The Hawaii Geothermal Project well HGP-A has undergone a two-year testing program which included cold water pumpdown tests, flashing flows with measurements of temperature and pressure profiles, and noise surveys. These tests and the data obtained are discussed in detail.

RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY

11789 (SGP-TR—28) **Stimulation and reservoir engineering of geothermal resources. First annual report, June 1, 1977-March 31, 1978.** Kruger, P.; Ramey, H.J. Jr. (Stanford Univ., CA (USA)). Apr 1978. Contract EY-76-S-03-0326-050. 68p. Dep. NTIS, PC A04/MF A01.

The large geothermal reservoir model has been used to investigate the specific energy extraction capabilities of various production methods and to determine the rate of heat loss from various rock formations. A parallel laboratory and field study in radon analysis is described. In order to quantify the emission rates of radon from reservoir rocks, an experimental apparatus is under construction to provide exact information on the temperature, pressure, and rock property dependence of the radon production. Laboratory cores were used in bench-scale experiments to determine steam/water relative permeability curves for permeable formation; to investigate the property of vapor pressure lowering of water confined in porous media at low saturations; and to determine the effects of high confining pressures and temperatures on the absolute permeability of porous rocks. The well test analysis and educatonal programs are reported. (MHR)

DIRECT ENERGY UTILIZATION

REFER ALSO TO CITATION(S) 11714, 11716, 11745, 11759, 11763

11790 (COO—4896-T1) **Process applications for geothermal energy resources. Progress report.** (Massachusetts Inst. of Tech., Cambridge (USA)). 1 Oct 1979. Contract ET-78-S-02-4896. 9p. Dep. NTIS, PC A02/MF A01.

Energy use characteristics of the major energy using industries in the US were examined. The pulp and paper industry was selected and a workshop held. Two analyses were performed of the potential for substituting geothermal energy for fossil fuel in specific pulp and paper plants. The lack of industry interest is discussed. (MHR)

11791 (DOE—27056-2) **Floral greenhouse heating. Semi-annual technical report.** Kunze, J.F.; Stoker, R.C. (Utah Roses, Inc., Sandy (USA)). Oct 1979. Contract EY-76-C-07-1570. 57p. (DOE/ET/27056—T1). Dep. NTIS, PC A04/MF A01.

A demonstration project for providing floral greenhouse space/process heat for a 6-acre greenhouse facility in metropolitan Salt Lake City has been jointly undertaken by the greenhouse owner (Utah Roses, Inc.) and the US Department of Energy. The work on the environmental evaluation was completed in March 1979, and the contract between the two principal organizations to proceed with the project was signed on May 1. Drilling of the first well is scheduled to commence by late October, with a target drilling depth of 3,000 to 4,000 feet. There are several shallow warm wells in the area, the closest being 100 yds from Utah Roses, and having 94°F temperatures at 750-foot depth. A minimum target temperature of 120°F has been set for the exploratory production well, which is to be drilled beginning in late October 1979.

11792 (DOE/ET/27026—T1) **Circulating pump impeller: Presbyterian Intercommunity Hospital, Klamath Falls, Oregon, geothermal heating system. Failure analysis report.** Mitchell, D.A.; Ellis, P.F. (Radian Corp., Austin, TX (USA)). 30 Nov 1979. Contract AC02-79ET27026. 16p. Dep. NTIS, PC A02/MF A01.

The Presbyterian Intercommunity Hospital located in Klamath Falls, Oregon utilizes geothermal fluid pumped from its own well to provide space heat and domestic hot water. During an inspection of the heating system after a chemical cleaning of the heat exchangers, the circulating pump was dismantled to replace its seals which were found to be leaking. At that time, the impeller was found to contain many cracks. The analysis of those cracks and a scale sample removed from the impeller is presented. (MHR)

11793 (NATO/CCMS—60) **Proceedings of the NATO-CCMS conference on the economics of direct uses of geothermal energy.** (Department of Energy, Washington, DC (USA). Div. of Geothermal Energy). Jul 1978. 363p. (CONF-770681—). Dep. NTIS, PC A16/MF A01.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

Twenty-six papers are included. Separate abstracts were prepared for twenty-five. One was abstracted for EDB previously. (MHR)

11794 (NATO/CCMS—60, pp 22-71) **Geothermal energy potential for district and process heating applications in the US: an economic analysis.** Bloomster, C.H.; Fassbender, L.L.; McDonald, C.L. (Battelle Pacific Northwest Labs., Richland, WA). Jul 1978.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

A preliminary economic assessment of the potential for geothermal energy to supply space and process heat in the US is provided. Supply curves (price-quantity relationships) were developed for both geothermal process heating and district heating applications for distances out to 50 miles. The 90°C to 150°C hydrothermal resources, which were identified in the assessment of geothermal resources by the US Geological Survey, contain usable energy for space and process heat equivalent to 50 billion barrels of oil. The sensitivity of production costs to the important factors of production was determined. The most important factors are well costs, well flow rate, resource temperature, distance separating demand and supply, population density, size of demand, and the system load factor. Although no technology breakthroughs are required in the utilization of geothermal energy for these nonelectric applications, technological advances are needed to reduce costs and increase the distances over which geothermal energy can be competitive. Significant cost reductions would be achieved by reducing well drilling costs, stimulating well flow rates, increasing productivity in pipeline construction, developing low cost pipeline materials, reducing fluid disposal costs and developing low cost energy storage capacity. (MHR)

11795 (NATO/CCMS—66, pp 149-171) **Potential for crop drying with geothermal hot water resources in the western United States. Alfalfa: a case study.** Wright, T.C. (The Futures Group, Glastonbury, CT). Jul 1978.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

Preliminary results of engineering, economic, and geographic analysis of the use of low-temperature geothermal heat for the commercial drying of grains, grasses, fruits, vegetables, and livestock products in the United States are reported. Alfalfa (lucerne) dehydration was chosen for detailed process and cost study. Six different geothermal heat exchanger/dryer configurations were examined. A conveyor type that could utilize geothermal hot water for its entire heat requirement proved to be the most economical. A capital cost estimate for an all-geothermal alfalfa dehydration plant near the Heber Known Geothermal Resource Area in the Imperial Valley, California was prepared. The combined cost for heat exchangers and dryer is about $1.6 million. Output is about 11 metric tons per hour. Acreage, production and dollar value data for 22 dryable crops were compiled for the areas surrounding identified hydrothermal resources in 11 western states. The potential magnitude of fossil fuel use that could be replaced by geothermal heat for drying these crops will be estimated.

11796 (NATO/CCMS—66, pp 179-181) **Engineering and economic studies of non-electric applications of geothermal heat.** Metzger, S.W. (EG and G, Idaho, Inc., Idaho Falls). Jul 1978.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

A collective body of paper studies addressing the engineering and economic aspects of the low-to-moderate temperature, nonelectric applications of hydrothermal resources were founded. The purpose of these studies was to expedite near-term commercialization in conjunction with technology transfer. They were to consider geothermal resources of 50 to 150°C for single or multiple uses in industrial processing, agribusiness, or commercial and residential space heating. Components of each study were to be the technical, economic, legal, institutional, social, and environmental aspects of non-electric applications of low-to-moderate temperature geothermal resources. Eighteen study contracts have been awarded, totaling about $2 million. Nine of the eighteen studies are described briefly.

11797 (NATO/CCMS—66, pp 183-188) **Far west perspective: geothermal non-electric initiatives in California, Hawaii, and Nevada.** Eggers, M. (Energy Research and Development Administration, Oakland, CA). Jul 1978.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

The three western states of Nevada, California, and Hawaii share a common problem: shortage of fossil fuels. Fortunately, they also have an abundant alternate energy resource: hydrothermal fluids of low to moderate (50°C to 150°C) temperature. The energy situation confronting these states and some of the specific ERDA-

sponsored projects underway which are aimed at alleviating the crunch facing industry and private citizens alike are discussed.

11798 (NATO/CCMS—66, pp 189-199) **Feasibility of developing geothermal energy industrial complexes.** Hornburg, C.D. (DSS Engineers, Inc., Ft. Lauderdale, FL). Jul 1978.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

The overall purpose was to provide economic, technical and other related information on developing industrial complexes which utilize geothermal energy. The basic concept was to select processes that may utilize large amounts of moderate temperature energy and group them together at specific geothermal sites for synergistic products in an optimum economic manner.

11799 (NATO/CCMS—66, pp 201-202) **Total energy recovery system for agribusiness.** Fisher, L.A.; Black, A.R.; Fogleman, S.F.; Singh, D.P. Jul 1978.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

11800 (NATO/CCMS—66, pp 215-222) **District heting in the Paris basin.** Aureille; Jaud; Lamethe. Jul 1978.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

The geothermal heating system in Creil is described and the first results of measurements taken during the winter of 1976-1977 are presented.

11801 (NATO/CCMS—66, pp 222-245) **Utilization and economics of geothermal space heating in Klamath Falls, Oregon.** Lienau, P.J.; Lund, J.W. (Oregon Inst. of Tech., Klamath Falls). Jul 1978.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

Klamath Falls, Oregon is located in a Known Geothermal Resource Area (KGRA) which has been used by residents, principally to obtain hot water for space heating, at least since the turn of the century. Approximately 400 shallow-depth wells ranging from 27 to 549 m in depth are used to heat approximately 500 structures. This utilization includes the heating of residences, schools, businesses (including a creamery for milk pasteurization), the heating of swimming pools, and the melting of snow from pavements. Well water, which ranges from 38° to 110°C has been used directly in heating and drinking-water systems; however, present practice is to use downhole hairpin-type heat exchangers with city water as the circulating fluid. Well water chemistry indicates approximately 800 mg/l (ppM) dissolved solids, with sodium and sulfate having the highest concentrations. Cost analyses for capital and annual operation costs are presented and compared with those for alternative forms of energy (electricity, natural gas, and fuel oil). For a single residence, at today's costs, heating by use of geothermal water appears to be somewhat competitive; however, when several structures use the same well, the savings are substantial. District heating, similar to that in operation in Iceland, is proposed. The annual energy utilization is only 56.4 GWh with peak use at 64 MW(t). It is felt that only a small portion of the area's potential is being utilized.

11802 (NATO/CCMS—66, pp 247-284) **GEOCITY model: description and application.** McDonald, C.L.; Bloomster, C.H. (Battelle Pacific Northwest Labs., Richland, WA). Jul 1978.

In Proceedings of the NATO/CCMS conference on the economics of direct uses of geothermal energy.

GEOCITY is described; following an overview of the program, the capabilities and approach of various model components are described. Results from the GEOCITY simulation are then compared with the actual Sudurnes distribution system design. GEOCITY is an offshoot of the GEOCOST computer program, which calculates the cost of generating electricity from geothermal resources. The reservoir model in GEOCITY is taken directly from GEOCOST. The distribution model is derived from a solar energy district heating model obtained from Sandia Laboratories. The GEOCITY program comprises the entire production, distribution, and waste disposal system for geothermal district heating applications but does not include the cost of radiators, convectors, or other in-house heating systems.

11803 (NATO/CCMS—66, pp 285-295) **Geothermal district heating system for Mammoth Lakes Village, California.** Racine, W.C.; Crane, G.K. Jul 1978.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

A study to determine the technical, environmental, and economic feasibility of using geothermal energy for domestic space and water heating in a winter resort town is being prepared under ERDA sponsorship. Detailed connected and peak heating load data have been collected and analyzed for electric resistance and propane gas heaters currently in use. Data from previous well tests and USGS work indicate a geothermal reservoir at nearby Casa Diablo Hot Springs of adequate size for a fully developed district heating system. Conceptual designs and cost estimates have been prepared for a closed, fresh water district heating loop which would extract heat from the geothermal liquid via a series of heat exchangers located near the geothermal wells, and for hydronic heating elements to be installed in residential and commercial buildings. An environmental analysis of the proposed district heating system has also been prepared. Results to date of the above work are discussed, along with plans for completing the feasibility evaluation.

11804 (NATO/CCMS—66, pp 297-303) **Direct heat utilization projects for California.** Willard, S. (California Energy Resources Conservation and Development Commission, Sacramento, CA). Jul 1978.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

The status of direct heat uses of geothermal energy in California is described, as well as specific projects currently supported by the California Energy Commission. (MHR)

11805 (NATO/CCMS—66, pp 341-357) **Improving the competitiveness of geothermal/direct use.** Kunze, J.F. (EG and G Idaho, Inc., Idaho Falls, ID). Jul 1978.

From NATO-CCMS conference on the economics of direct uses of geothermal energy; Washington, DC, USA (21 Jun 1977).

The research, development, and demonstrations of direct utilization of geothermal heat conducted over the last four years at the Idaho National Engineering Laboratory are described briefly. The effort has been locally oriented toward the needs of the present and future Intermountain West, primarily the states of Utah, Idaho, Oregon, Washington, Montana, Wyoming, Colorado, and Nevada. As more and more geochemical indicators were obtained from various wells and hot springs in the area, it became apparent that there is a great abundance of moderate-temperature reservoirs, rather than the high-temperature reservoirs which are attractive for the production of electricity. Below temperatures of 180°C, electric generation is not considered competitive with fossil fuel using current geothermal technology. Therefore, if a significant impact is to be made by geothermal energy, we must make more extensive applications of the moderate- to low-temperature water from 60°C to 180°C. There are many possible uses, but the most significant for the states mentioned above would be space heating. With the cool climate in this area of the country, nearly 30% of the energy use is for space and water heating.

11806 (NMEI—42) **Use of geothermal energy for desalination in New Mexico: a feasibility study. Final report, January 1, 1977-May 30, 1979.** Chaturvedi, L.; Keyes, C.G. Jr.; Swanberg, C.A.; Gupta, Y.F.; Davis, R.J. (New Mexico State Univ., Las Cruces (USA). New Mexico Energy Inst.). Jun 1979. 145p. New Mexico State Univ., New Mexico Energy Inst., Las Cruces.

The water requirements and availability for New Mexico are described. The possibility of using geothermal resources for desalination of the state's saline water sources is discussed. The following aspects of the problem are covered: resource evaluation, geothermal desalination technology, potential geothermal desalination sites, saline and geothermal aquifer well fields design, geothermal desalination plant waste brine disposal, process water pumping and brine disposal unit costs, environmental considerations, and legal and institutional considerations. (MHR)

11807 (SAN—1743-3) **Engineering and economic analysis for the utilization of geothermal fluids in a cane sugar processing plant. Final report.** Humme, J.T.; Tanaka, M.T.; Yokota, M.H.; Furumoto, A.S. (Puna Sugar Co., Honolulu, HI (USA)). Jul 1979. Contract ET-78-C-03-1743. 283p. Dep. NTIS, PC A13/MF A01.

The purpose of this study was to determine the feasibility of geothermal resource utilization at the Puna Sugar Company cane sugar processing plant, located in Keaau, Hawaii. A proposed well site area was selected based on data from surface exploratory surveys. The liquid dominated well flow enters a binary thermal arrangement, which results in an acceptable quality steam for process use. Hydrogen sulfide in the well gases is incinerated, leaving sulfur dioxide in the waste gases. The sulfur dioxide in turn is recovered and used in the cane juice processing at the sugar factory. The clean geothermal steam from the binary system can be used directly for process requirements. It replaces steam generated by the firing of the waste fibrous product from cane sugar processing. The waste product, called bagasse, has a number of alternative uses, but an evaluation clearly indicated it should continue to be employed for steam generation. This steam, no longer required for process demands, can be directed to increased electric power generation. Revenues gained by the sale of this power to the utility, in addition to other savings developed through the utilization of geothermal energy, can offset the costs associated with hydrothermal utilization.

GEOTHERMAL DATA AND THEORY

PROPERTIES OF MINERALS AND ROCKS

REFER ALSO TO CITATION(S) 11735

11808 (IDO—1601-T14) **Fluid dynamic properties of rhyolitic magmas, Mineral Mountains, Utah. Part I: volatile content and flow characteristics. Part II: physical properties.** Nash, W.P.; Evans, S.H. Jr. (Utah Univ., Salt Lake City (USA). Dept. of Geology and Geophysics). Jul 1978. Contract EY-76-S-07-1601. 47p. Dep. NTIS, PC A03/MF A01.

Rhyolites from southwestern Utah are described that display striking dissimilarities in morphology which are attributed to viscosity differences due to variations in water content. Temperature effects and fluorine concentrations are unable to account for the observed differences in morphology. Fluid dynamic calculations indicate that rhyolite flows of fluid aspect contained between 1 and 3 percent water upon eruption. More viscous domes contained less water which was expelled in pyroclastic eruptions preceeding emplacement of the domal rhyolite magma. The results of calculations are presented that determine the physical properties of rhyolite magmas in the Mineral Mountains. Data are presented on density, molar volume, heat capacity, gram formula mass, dynamic viscosity, thermal conductivity, thermal diffusivity, kinematic viscosity, and coefficient of thermal expansion.

11809 (IDO—1650-T1) **Rock properties in support of geothermal resource development.** Butters, S.W. (Terra Tek, Inc., Salt Lake City, UT (USA)). 1979. Contract EG-77-C-07-1650. 71p. Dep. NTIS, PC A04/MF A01.

Geothermal rock mechanics needs have been defined and subsequently a test system was designed and built for providing appropriate material properties. The development areas identified as requiring rock mechanics were stimulation, reservoir engineering, subsidence prediction, surface exploration and subsurface evaluation, and drilling. The resulting test system provides mechanical, electrical, thermal and physical properties on 2 and 4 inch diameter cores at confining pressures and pore fluid pressures to 200 MPa (30,000 psi) and temperatures to 535°C (1000°F). The test system development was continued and site specific rock mechanics requirements were identified. (MHR)

ROCK-WATER-GAS INTERACTIONS

11810 (LA—8102-MS) **Rock physics characterization of Conway granite from a DOE borehole, Conway, New Hampshire.** Warren, N. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 52p. Dep. NTIS, PC A04/MF A01.

The Conway granite of New Hampshire is a highly radioactive intrusive into which a 1-km-deep borehole was drilled and continuously cored in 1975. There are two major granitic units, the Osceola and the Conway. The Conway is cut by three lamprophyre dikes. Elastic moduli and petrographic studies were on 14 samples from the core. These data and observations have been used to determine groupings in the rocks by characterizing microstructure. An important result is that carefully taken physical properties data (for example, velocities and strains) are sensitive indicators of microstructure. Based on velocity and strain data, three distinct groups are found: the lamprophyre dike rocks and two groups each of which contain samples from both the Osceola and Conway formations. These groups are also distinguished by petrographic observations of microcrack patterns. The groups are apparently controlled by grain size and by uniformity of the mixing of the mineral phases in the samples, and not by mineral modes or depth. This last result implies the coring of the Conway samples may have intensified the amount of cracking over that in the rocks in situ, but not the type of cracking. Coring does not apparently induce a distinct population of very thin (low aspect ratio) cracks; that is, such cracks are not needed to explain the low pressure stress and velocity data of these samples.

11811 (LA-UR—79-3113) **Experimentally determined rock-fluid interactions applicable to a natural hot dry rock geothermal system.** Charles, R.W.; Holley, C.E. Jr.; Tester, J.W.; Blatz, L.A.; Grigsby, C.O. (Los Alamos Scientific Lab., NM (USA)). Feb 1980. Contract W-7405-ENG-36. 23p. (CONF-800205—1). Dep. NTIS, PC A02/MF A01.

From American Institute of Metallurgical Engineers meeting; Las Vegas, NV, USA (Feb 1980).

The Los Alamos Scientific Laboratory is pursuing laboratory and field experiments in the development of the Hot Dry Rock concept of geothermal energy. The field program consists of experiments in a hydraulically fractured region of low permeability in which hot rock is intercepted by two wellbores. These experiments are designed to test reservoir engineering parameters such as: heat extraction rates, water loss rates, flow characteristics including impedance and buoyancy, seismic activity and fluid chemistry. Laboratory experiments have been designed to provide information on the mineral reactivity which may be encountered in the field program. Two experimental circulation systems have been built to study the rates of dissolution and alteration in dynamic flow. Solubility studies have been done in agitated systems. To date, pure minerals, samples of the granodiorite from the actual reservoir and Tijeras Canyon granite have been reacted with distilled water and various solutions of NaCl, NaOH, and Na_2CO_3. The results of these experimental systems are compared to observations made in field experiments done in a hot dry rock reservoir at a depth of approximately 3 km with initial rock temperatures of 150 to 200°C.

TIDAL POWER

TIDAL POWER PLANTS

DESIGN AND OPERATION

11812 (PB—291989-T/SL) **Kislogubskaya tidal electric power station.** Bernshtein, L.B.; Gavrilov, V.G.; Gel'fer, S.L.; Nekoroshev, N.N.; Siponitskii, L.I. (Cairo Univ. (Egypt)). 1978. Translation of Kislogubskaya Prilivnaya Elektrostanciya, Moscow, 1972. 299p. NTIS, PC A13/MF A01.

The book discusses the experiment of projecting, constructing, and investigating an experimental Kislogubskaya tidal electrostation, which was created for testing new methods of tidal energy application and was first realized when constructing GES State Electric Power Plant.

WAVE ENERGY CONVERTERS

11813 (ORO—5669-T1) **Protonic conduction wave energy converter. Final report, January 1-December 31, 1978.** Salomon, R.E. (Temple Univ., Philadelphia, PA (USA). Dept. of Chemistry). 1979. Contract ET-78-S-05-5669. 80p. Dep. NTIS, PC A05/MF A01.

An initial study of the feasibility of using electrochemical hydrogen concentration cells with protonic conductors for the conversion of ocean wave energy into electricity has been carried out. The system considered uses the potential energy of waves or ocean swells to alternately compress and expand hydrogen gas which thereby drives a concentration cell. A theoretical analysis of four idealized embodiments of the device, incorporated within a taut-moored buoy, has shown that the key to efficient conversion is sufficiently low electrode and electrolyte resistance. One of the pivotal assumptions in this analysis is that the system can respond in the time of an ocean wave period to the pressure oscillations. Accordingly, this assumption was tested experimentally using Nafion and filter paper impregnated with hydrochloric acid as the electrolytes and platinum as the electrode material. The assumption was experimentally validated and the power delivered by these cells under conditions of simulated three foot waves was measured as a function of load resistance and temperature. The power exhibited a peak as a function of load resistance and temperature. The power exhibited a peak as a function of load resistance, increased with a rise in temperature and sharply increased with an enhancement of the water content of the Nafion. The two latter observations are indicative of the importance of low cell resistance in achieving high conversion efficiencies. By combining the experimental results on power and cell resistance with results of the theoretical analysis of a potential system, it is concluded that 250 watts can be obtained from one square meter of ocean in a three foot sea. This 25% conversion efficiency can be obtained with presently available materials (Nafion and porous platinum electrodes).

WIND ENERGY

AVAILABILITY (CLIMATOLOGY)

REFER ALSO TO CITATION(S) 11820

11814 (UHMET—79-15) **Hawaii wind power survey: fixed station data.** Ramage, C.S.; Oshiro, N.E.; Yokogawa, S.T. (Hawaii Univ., Honolulu (USA). Dept. of Meteorology). Dec 1979. Contract EG-77-G-03-1617. 66p. Dep. NTIS, PC A04/MF A01.

Winds are measured at windy locations in the Hawaiian Islands for periods ranging from 9 to 40 months. Careful calibration and comparison with the nearest airport measurements allow for correction or elimination of bad data. The differences were suffi-

ciently small to justify computing speed duration and power density, and diurnal variations of wind speed and power density for each station. A significant area on each island possesses high annual wind power [power density at 50 m (164) AGL exceeding 400 W m^{-2}]. The monitoring of the strong wind area of northwest Molokai, until now sampled only during a mobile survey, is outlined. Plans include making detailed measurements of the turbulence characteristics and the vertical profile of the wind in each of the major strong wind areas.

REGULATIONS

11815 (SERI/TR—354-365) **Product liability and small wind energy conversion systems (SWECS): an analysis of selected issues and policy alternatives.** Noun, R.J. (Solar Energy Research Inst., Golden, CO (USA)). Dec 1979. Contract EG-77-C-01-4042. 49p. Dep. NTIS, PC A03/MF A01.

An overview is presented of the various legal issues regarding SWECS performance and safety, according to when such issues may arise during the SWECS manufacturing and marketing processes. Next, the most significant issues are translated into a series of questions, followed by a legal analysis that addresses these questions within the framework of the present product litigation system. The special problems presented to SWECS by judicial treatment of design defect cases and the relevance of industry standards in product cases are emphasized. Finally, a number of policy alternatives for DOE and others to consider are examined concerning their relative advantages and disadvantages in dealing with selected issues.

WIND ENERGY ENGINEERING

REFER ALSO TO CITATION(S) 11642

11816 (PB—290694) **Wind Engineering Research Digest. Volume 3. 1978. Periodic report 1975-78.** Chiu, A.N.L. (Hawaii Univ., Honolulu (USA). Dept. of Civil Engineering). Nov 1978. 174p. NTIS, PC A08/MF A01.

Research activity in wind engineering (or environmental aerodynamics) has expanded rapidly throughout the United States. The Wind Engineering Research Digest keeps track of this far flung research effort, and publishes a summary of on-going research projects at annual intervals. Topic areas discussed include the following: Structure of wind; wind-wave effects; effects on urban areas; wind loading on structures; severe storms; design for hurricanes and tornadoes; full-scale testing; model testing; environmental factors; psycho-physical factors; legal factors; special problems; wind considerations in urban planning; building codes and regulations; socio-economic effects; international cooperation; and wind energy.

APPLICATIONS

REFER ALSO TO CITATION(S) 11619

11817 (DOE/TIC—10227) **Wind powered heat pump in a dairy farm application. Final report.** Curtis, G.B. (Kaman Sciences Corp., Colorado Springs, CO (USA)). 16 Oct 1978. 177p. Dep. NTIS, PC A09/MF A01.

A 30-foot high and 20-foot diameter Darrieus wind turbine was installed on a 120-cow dairy farm. The wind turbine generated 3-phase electrical power which was used, in parallel with utility power, to operate the refrigeration equipment for milk cooling at the dairy farm. A milk precooler and heat recovery from the refrigeration condenser were also installed to supply the warm water requirements of the dairy. The system was operated for 183 days and its performance, along with wind measurements for the same period, was analyzed to yield predictions for the size of wind turbine required to supply needed energy and the size of ice storage unit needed to store refrigeration capacity over periods of low wind.

11818 (PB—292816) **Wind driven water pumps. Economics, technology, current activities.** Blake, S. (Appropriate Technology Group, Oskaloosa, KS (USA)). 1978. 29p. NTIS PC A03/MF A01.

The illustrated handbook discusses the economics and the characteristics typical of the aermotor windmill and the indigenous windmill. Since the use of windmills can have worldwide impact upon the development and upgrading of water supplies, an emphasis is placed upon the importance of supplying this technical information to the developing countries of the world.

11819 (PB—294017) **An improved computer program for calculating the theoretical performance parameters of a propeller type wind turbine. An appendix to the final report on feasibility of using wind power to pump irrigation water (Texas).** Barieau, R.E. (Texas Governor's Energy Advisory Council, Austin (USA). Forecasting and Policy Analysis Div.; West Texas State Univ., Canyon (USA). Dept. of Physics). Mar 1977. 71p. NTIS, PC A04/MF A01.

The PROP Program of Wilson and Lissaman has been modified by adding the Newton-Raphson Method and a Step Wise Search Method, as options for the method of solution. In addition, an optimization method is included. Twist angles, tip speed ratio and the pitch angle may be varied to produce maximum power coefficient. The computer program listing is presented along with sample input and output data. Further improvements to the program are discussed.

11820 (PNL-SA—7270) **Wind characteristics for agricultural wind energy applications.** Renne, D.S. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jan 1979. Contract EY-76-C-06-1830. 5p. (CONF-7904120—1). Dep. NTIS, PC A02/MF A01.

From 14. conference on agriculture and forest meteorology; Minneapolis, MN, USA (2 Apr 1979).

Wind energy utilization in agriculture can provide a potentially significant savings in fuel oil consumption and ultimately a cost savings to the farmer. A knowledge of the wind characteristics within a region and at a location can contribute greatly to a more efficient and cost-effective use of this resource. Current research indicates that the important wind characteristics include mean annual wind speed and the frequency distribution of the wind, seasonal and diurnal variations in wind speed and direction, and the turbulent and gustiness characteristics of the wind. Further research is underway to provide a better definition of the total wind resource available, improved methods for siting WECS and an improved understanding of the environment to which the WECS respond.

TURBINE DESIGN AND OPERATION

11821 (COO—2615-T2) **Experimental and analytical research on the aerodynamics of wind driven turbines. Final report.** Rohrbach, C.; Wainauski, H.; Worobel, R. (United Technologies Corp., Windsor Locks, CT (USA). Hamilton Standard Div.). Dec 1977. Contract EY-76-C-02-2615. 260p. Dep. NTIS, PC A12/MF A01.

The successful development of reliable, cost competitive horizontal axis, propeller-type wind energy conversion systems (WECS) is strongly dependent on the availability of advanced technology for each of the system components. This aerodynamic research program was aimed at providing a reliable, comprehensive data base on a series of wind turbine models covering a broad range of the prime aerodynamic and geometric variables. Such data obtained under controlled laboratory conditions on turbines designed by the same method, of the same size, and tested in the same wind tunnel had not been available in the literature. Moreover, this research program was further aimed at providing a basis for evaluating the adequacy of existing wind turbine aerodynamic design and performance methodology, for assessing the potential of recent advanced theories and for providing a basis for further method development and refinement.

11822 (COO—4130-2) **Third annual progress report on the electrofluid dynamic wind generator. Final report, September 15, 1977-September 30, 1978.** Minardi, J.E.; Lawson, M.O.; Wattendorf, F.L. (Dayton Univ., OH (USA). Research Inst.). May 1979. Contract EY-76-S-02-4130. 76p. Dep. NTIS, PC A05/MF A01.

The objective of the program is to conduct research leading to the development of EFD wind driven generators. In such generators, the wind blows through suitably oriented arrays of electrodes, transports charged particles against an electrical potential gradient, and thereby generates electrical power directly without moving parts. Significant progress has been made in accomplishing major research objectives. During the past year, the effort was directed toward the achievement of three milestones, namely: development of a laboratory method for the production of an adequate supply of suitably low mobility charged droplets for the testing of generator performance; experimental verification of generator performance theory; and development of methods for practical production of charged droplets.

11823 (COO—4150-77/8) **Design of a self-regulating composite bearingless blade wind turbine. Final report, October 15, 1976-August 15, 1977.** Spierings, P.A.M.; Cheney, M.C. (United Technologies Research Center, East Hartford, CT (USA)). Jan 1978. Contract EG-77-C-02-4150. 69p. Dep. NTIS, PC A04/MF A01.

A study was undertaken to design a 40-ft diameter wind turbine employing the UTRC/ERDA Self-Regulating Composite Bearingless Rotor (CBR) concept. The CBR concept was developed at United Technologies for rotary wing applications and is now in use on Sikorsky helicopters. The concept was further developed for wind turbine applications at UTRC under an ERDA contract in 1975-76. Successful wind tunnel tests were conducted during that contract, which demonstrated the self-starting and self-regulating features. The latest contract was to design a 40-ft system in the 5 kW - 15 kW power range. This effort included performance tradeoff studies, stress analyses of the blade and tower structure, a stability investigation, and engineering drawings of the complete system. However an overall cost analysis was not performed in this study.

11824 (COO—4206-10) **Security assessment of power systems including energy storage and with the integration of wind energy. Progress report, July 1-September 30, 1979.** Carroll, D.P.; Krause, P.C. (Purdue Univ., Lafayette, IN (USA). School of Electrical Engineering). Oct 1979. Contract AS02-77ET29100. 5p. Dep. NTIS, PC A02/MF A01.

The progress of the first three tasks of the wind energy part of the contract is discussed. Emphasis is on the modeling of the wind and the detailed computer representations of three candidate wind systems; namely, MOD-1, MOD-2 and the Shackle machine. Once the detailed computer representations of these wind systems have been developed the next step is to begin work on the reduced order models to be used in transient stability programs.

11825 (DSE—2554-78/2(Vol.1)) **Analysis of the Madaras Rotor Power Plant: an alternate method for extracting large amounts of power from the wind. Executive summary.** Whitford, D.H.; Minardi, J.E.; West, B.S.; Dominic, R.J. (Dayton Univ., OH (USA). Research Inst.). Jun 1978. Contract EX-76-S-01-2554. 51p. Dep. NTIS, PC A04/MF A01.

The purpose of the program was to analyze and up-date the design of the Madaras Rotor Power Plant concept that had been developed in the 1930's to determine the technical and economic feasibility of this system to be competitive with conventional horizontal axis wind turbines. The Madaras concept uses rotating cylinders, vertically mounted on flat cars, to react with the wind like a sail and propel an endless train of connected cars around a closed track at constant speed. Electricity is generated by alternators on each car that are geared to the wheels. Electrical power is transmitted from each car to the power house by a trolley system. A four-task program consisting of a series of wind tunnel tests, an electro-mechanical analysis, a performance analysis, and a cost analysis was conducted.

11826 (DSE—2554-78/2(Vol.2)) **Analysis of the Madaras Rotor Power Plant: an alternate method for extracting large amounts of power from the wind. Volume 2. Technical report.** Whitford, D.H.; Minardi, J.E.; West, B.S.; Dominic, R.J. (Dayton Univ., OH (USA). Research Inst.). Jun 1978. Contract EX-76-S-01-2554. 423p. Dep. NTIS, PC A18/MF A01.

The purpose of the program was to analyze and up-date the design of the Madaras Rotor Power Plant concept that had been developed in the 1930's to determine the technical and economic feasibility of this system to be competitive with conventional horizontal axis wind turbines. A four-task program consisting of a series of wind tunnel tests, an electro-mechanical analysis, a performance analysis, and a cost analysis was conducted.

11827 (ORO—5135-77/5) **Vertical axis wind turbine development. Final report, March 1, 1976-June 30, 1977.** Walters, R.E.; Fanucci, J.B.; Hill, P.W.; Migliore, P.G. (West Virginia Univ., Morgantown (USA). Dept. of Aerospace Engineering). Jul 1979. Contract EY-76-C-05-5135. 243p. Dep. NTIS, PC A11/MF A01.

Theoretical and experimental research accomplished in evaluating an innovative concept for vertical axis wind turbines (VAWT) is described. The concept is that of using straight blades composed of circulation controlled airfoil sections. The theoretical analysis has been developed to determine the unsteady lift and moment characteristics of multiple-blade cross-flow wind turbines. To determine the drag data needed as input to the theoretical analysis, an outdoor test model VAWT has been constructed; design details, instrumentation, calibration results, and initial test results are reported. Initial testing was with fixed pitch blades having cross-sections of conventional symmetrical airfoils. Costs of building the test model are included, as well as cost estimates for blades constructed with composite materials. These costs are compared with those of other types of wind turbines.

11828 (ORO—5135-77/5(Summ.)) **Vertical axis wind turbine development. Executive summary. Final report, March 1, 1976-June 30, 1977.** Walters, R.E.; Fanucci, J.B.; Hill, P.W.; Migliore, P.G. (West Virginia Univ., Morgantown (USA). Dept. of Aerospace Engineering). Jul 1979. Contract EY-76-C-05-5135. 26p. Dep. NTIS, PC A03/MF A01.

Information is presented concerning the numerical solution of the aerodynamics of cross-flow wind turbines; boundary layer considerations for a vertical axis wind turbine; WVU VAWT outdoor test model; low solidity blade tests; high solidity blade design; cost analysis of the WVU VAWT test model; structural parametric analysis of VAWT blades; and cost study of current WECS.

11829 (PB—294413) **A low-cost water pumping windmill using a sail type Savonius rotor.** Raju, S.P.G.; Narasimha, R. (California Univ., Los Angeles (USA). Dept. of Geology). Jan 1979. 110p. NTIS PC A06/MF A01.

A water pumping windmill which can be built largely using materials and skills available in rural areas has been designed and fabricated. The windmill uses a Savonius rotor and incorporates a novel sail type construction. The pump is of positive displacement type using the casing of a pneumatic tire for the pumping chamber. Two prototypes have been constructed and these have indicated a reasonable performance and reliability.

11830 (RFP—3027/67025/3533/79-9) **Structural dynamics, stability, and control of high aspect ratio wind turbines.** Stoddard, F.S. (Massachusetts Univ., Amherst (USA). Energy Alternatives Program). Dec 1978. Contract EY-76-C-04-3533. 311p. Dep. NTIS. PC A14/MF A01.

The blade dynamics and vibration of wind turbine generators with high aspect ratio (slender) blades are developed. Equations of motion are derived, and blade motions and forces are found, for degrees of freedom in flapping, lead-lag and feathering subject to gravity, crosswind, yaw rate, and axisymmetric aerodynamic forces. Tower degrees of freedom are added to assess tower loads and vibration. Significant mechanical and aeroelastic instabilities which may occur are predicted and discussed. Methods are developed, and quantitative computer programs are given, for the structural and vibration analysis of twisted, tapered, composite shell blades. The University of Massachusetts Wind Furnace I, which is the impetus of this study, is described.

SITE CHARACTERISTICS

REFER ALSO TO CITATION(S) 12487

ELECTRIC POWER ENGINEERING

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 11598, 11630, 12040

11831 (AD-A—068505) **Power system analysis. Final report.** Burkes, T.R.; Craig, J.P.; Gustafson, D.L. (Texas Tech Univ., Lubbock (USA)). Jan 1979. Contract F29601-75-C-0111. 82p. NTIS, PC A05/MF A01.

This report describes the system analysis performed on a lightweight, high-power power system. The system consists primarily of the turboalternator, rectifier/filter, and fault protection circuits. The determination of and effects from various alternator faults are described. Calculations for the filter weight and volume and a grounding and shielding scheme are presented. A design concept for a load protection crowbar is developed. Because a small, high voltage power supply is required for an electron-beam gun, methods of generating high voltages in small packages are reviewed. Also included is a review of the state of the art of lightweight power sources, including advanced conventional, permanent magnet, and superconducting alternators, magnetohydrodynamic generators (MHD), and batteries.

11832 (PB—292943) **Power plant training course - steam accessories. Technical bulletin.** (Armstrong Cork Co., Lancaster, PA (USA)). Mar 1961. 54p. NTIS PC A04/MF A01.

This presentation on steam accessories was developed to help train employees to understand facts of importance about accessories. To avoid confusion, no attempt has been made to cover all the accessories of all manufacturers. The information given here does include A.S.M.E. types --- a knowledge of which will help anyone understand accessories of the same types.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

REFER ALSO TO CITATION(S) 11842

11833 (PB—290702) **Brackish ground water for power plant cooling in california. Final report.** Scott, V.H.; Scalmanini, J.C.; Popko, K.A. (California Univ., Davis (USA). Dept. of Land, Air, and Water Resources). Nov 1978. 118p. NTIS, PC A06/MF A01.

Cooling water requirements for a single power plant can be as high as 25,000 acre feet per year. In certain parts of California, there appears to be potential for developing water supplies from groundwater basins, but questions remain regarding total reliance on groundwater for medium to large plants (400 to 1600 MW). To supply cooling water for a 1600 MW coal fired plant, 20 wells producing 800-1000 gpm would be required in a field of up to 12 square miles. This report provides a general evaluation of California's ground water resources, the geographic location of brackish water basins and an assessment of the use of brackish water for cooling. Also the feasibility of using such resources is discussed in terms of economical, environmental legal, and technical considerations. Various categories were established for a uniform analysis of individual reservoirs and aquifers. These include storage capacity,

water levels, subsurface flows, replenishment yield, seawater intrusion, types of uses and geology.

11834 (PB—293572) **An investigation of the accuracy of the Merkel equation for evaporative cooling tower calculations. Waste heat management.** Yadigaroglu, G.; Pastor, E.J. (California Univ., Berkeley (USA). Dept. of Nuclear Engineering). Jan 1974. 30p. NTIS PC A03/MF A01.

The exact differential equations governing heat and mass transfer and air flow in an evaporative, natural-draft cooling tower are presented. The Merkel equation is then derived starting from this exact formulation and showing all the approximations involved. The Merkel formulation lumps the sensible and the latent heat transfer together and considers a single enthalpy-difference driving force for the total heat transfer. The effect of the approximations inherent in the Merkel equation is investigated and analyzed by a series of parametric numerical calculations of cooling tower performance under various ambient conditions and load conditions.

POWER CYCLES

REFER ALSO TO CITATION(S) 11769, 11771, 12060

11835 (FE—1806-48) **Development of high-temperature turbine subsystem technology to a "technology readiness status". Phase II. Quarterly report, April-June 1978.** (General Electric Co., Schenectady, NY (USA). Gas Turbine Div.). Jul 1978. Contract EX-76-C-01-1806. 185p. Dep. NTIS, PC A09/MF A01.

The objective of the High-Temperature Turbine Technology (DOE-HTTT) program is to bring to technology readiness, over a six- to ten-year duration, a high-temperature turbine for use in a combined cycle, using coal-derived fuel at a firing temperature of 2600°F with growth capability to 3000°F. Phase I, Program and System Definition, was completed and progress in Phase II, Technology Testing and Test Support Studies, is reported. The objectives of Phase II are to: perform component design and technology testing in critical areas; perform system design and trade-off analyses in sufficient depth to support the component design and test tasks; and update the Phase I combined cycle studies to evaluate the commercial viability of a GE-TRV turbine system. Information is included on hot gas path development test facilities, turbine simulator tests, shock tunnel test, low-temperature, low-BTU gas cleanup system, motorized rig tests, air turbine tests, liquid- and gas-fueled combined-cycle power plants, turbine subsystem design, update of verification test system definition (GE-TRV), and technology readiness vehicle (GE-TRV) design. (LCL)

11836 (PB—291794) **Feasibility and economics of cogeneration in California's thermal enhanced oil recovery operations. Final report.** Henwood, M. (California Energy Commission, Sacramento (USA)). Dec 1978. 203p. NTIS, PC A10/MF A01.

The large quantities of steam injected into oil wells to increase production by the process of thermal enhanced oil recovery (EOR) can also be used to generate electricity at some sites. This report determined which California oil fields are suitable for cogeneration, the generation capacity possible, the appropriate fuel, and the economics of coal use for noncogeneration steam production at oil fields.

COMPONENTS

REFER ALSO TO CITATION(S) 11187

11837 (PB—292881) **General operating rules for power boilers.** Wickat, R.G. (Armstrong Cork Co., Lancaster, PA (USA)). 23 Mar 1950. 32p. NTIS PC A03/MF A01.

The manual is one of a series of training manuals. The suggested Rules 'Case of Power Boilers' promulgated by the American Society of Mechanical Engineers, the American Boiler Manufacturers Association, and various Political Sub-Division Authorities have been used as a guide in the preparation of these General Rules.

ECONOMICS

REFER ALSO TO CITATION(S) 12004, 12005

11838 (JPL-PUBL—78-56, pp 296-299) **Fuel adjustment clauses for California.** Rush, N.E. (Ernst & Ernst, Washington, DC). 15 Aug 1978.

From Conference on coal use for California; Pasadena, CA, USA (9 May 1978).

California is blessed with an unusual advantage in that it has the opportunity to adequately prepare for a smooth transition into the use of coal for generation of electricity and can benefit from the successes and failures of other commissions and utilities. It is strongly urged that the State do several things - first the Commission should implement a good fuel adjustment clause structured specifically to handle coal, second the utilities should prepare good coal procurement procedures that fully address the five areas discussed and ensure that the procurement actions are adequately documented and, lastly, the Commission should implement a good monitoring program through which the consumers and the Commission can be assured that good procurement decisions are being made. If the State will work together to do these things and if they will begin now, then California will be able to fully benefit from the use of coal to generate electricity in California.

OFF-PEAK ENERGY STORAGE

REFER ALSO TO CITATION(S) 11960

11839 (DOE/ET/1214—T1) **Impacts of dispersing storage and generation in electric distribution systems. Final report.** Ma, F.S.; Isaksen, L.; Patton, R. (Systems Control, Inc., Palo Alto, CA (USA)). Jul 1979. Contract EY-76-C-03-1214. 250p. Dep. NTIS, PC A11/MF A01.

Small-scale Dispersed Storage and Generation (DSG) connected to the electric-distribution systems provide one alternative to large-scale additions to utility supply and delivery systems. In addition to being generating sources, DSG may also provide benefits to the distribution system by reducing capacity requirements, improving reliability, and lowering losses. This study offers a consistent, unifying methodology for evaluating the dispersion effect of DSG in distribution systems. The evaluation method and models developed compare the distribution systems expanded with and without DSG, using a consistent set of planning and operating criteria. The effects of DSG outages probabilities, diseconomies of scale, and loss savings are explicitly treated. The method also takes into account the effect on the bulk-supply system when DSG is planned and operated for distribution-system needs. To obtain the overall DSG impact on a utility system, the results derived from this methodology can readily be combined with the impact of the technologies assessed from a bulk-supply perspective undertaken in other studies. This assessment methodology would be suitable for use by most utilities since it is based on extant utility planning procedures and data bases, and practical assessment calculating. Application of this methodology for two utilities showed that the distribution capacity and reliability benefits are highly site-dependent, and that potentially higher production cost and DSG capital cost may be incurred. The study points to the importance of caution and comprehensive assessment before implementing DSG in the distribution system on a large scale.

FUELS

REFER ALSO TO CITATION(S) 11197

11840 (AD-A—069374) **Evaluation of alternatives for restoring the south boiler house at Joliet AAP to high-sulfur-coal burning capability. Final report.** Donahue, B.A.; Hathaway, S.A.; Schanche, G.; Struss, S. (Army Construction Engineering Research Lab., Champaign, IL (USA)). May 1979. 43p. NTIS, PC A03/MF A01.

This report evaluates alternatives for restoring the south boiler house at the Joliet Army Ammunition Plant to burn high-sulfur coal in an environmentally acceptable manner. The boiler house was examined to assess its coal handling and burning capability. Various flue-gas cleaning devices were then field evaluated to determine their potential application at the Joliet plant for particulate removal and for flue-gas desulfurization.

11841 (DOE/FERC—0002/1) **Staff report on monthly report cost and quality of fuels for electric utility plants. FPC form No. 423. Data for November 1977.** (Department of Energy, Washington, DC (USA)). Apr 1978. 61p. Dep. NTIS, PC A04/MF A01.

Electric generating plants with a total combined capacity of 25 MW or greater purchased fossil fuel equivalent to 1.5 quadrillion Btu's in Nov. 98.9% of which was for steam-electric generation. Measured by their total heat content, fossil fuel purchases for steam-electric generation were up 1.7% from last month and up 11.6% from Nov. 1976. Deliveries of coal totaled 48.3 million tons, an increase of 8.2 million tons above shipments made during Nov. 1976. Oil purchases for steam-electric generation reached 39.6 million barrels this month, a decrease of 5.6 million barrels below shipments made in Nov. of last year. Gas deliveries to steam-electric units total 219.2 billion ft^3 up 6.6% from last year's level. In Nov., the price of coal averaged 101.7 cents per millin Btu, a rise of 17.4% over the average price of a year ago. The average price of all oil delivered to steam plants was 219.3, a rise of 6.2% compared to Nov. 1976. Steam gas purchases averaged 134.9 cents per million Btu, an increase of 19.3% over the Nov. 1976 level. The following tabulations highlight the relative changes in deliveries and prices of fossil fuels for steam-electric generation for Nov. 1976 and Nov. 1977.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 11130, 12048, 12443, 12454, 12461, 12523, 12533, 12542, 12647

11842 (COO—2381-2) **Environmental assessment of Chalk Point cooling tower drift and vapor emissions.** Davis, E.A. (Johns Hopkins Univ., Laurel, MD (USA). Applied Physics Lab.). Mar 1979. Contract EY-76-C-02-2381. 200p. Dep. NTIS, PC A09/MF A01.

An assessment is provided of selected environmental effects of operating the cooling towers and stacks of Units No. 3 and No. 4 of the Potomac Electric Power Company's generating station at Chalk Point, Maryland. The emphasis is on the magnitude of salt deposition to the area surrounding the cooling tower due to saline water drift. A secondary but important consideration is the magnitude of salt loading due to saline drift from the stack which uses saline river water in scrubbing flue gases. This salt loading together with that of the ambient salt background is assessed for its effects on soils, crops, native vegetation and man-made structures. Other atmospheric effects examined are: enhancement of ground level fogging and icing, enhancement of precipitation, and the flight hazards to aircraft. A numerical model of drift deposition has been developed and validated against the data collected in the Dyed Drift Experiment at Chalk Point. Use of the available data model predictions indicate that with fulltime, full load operation of both 600 MW(e) units significant levels of salt deposition occur only on the plant site within 0.4 km of the source. The predicted maximum salt deposition rates are given. The effects on soils, crops and native vegetation are predicted to be negligible at off-site locations. Significant effects to foliage of dogwood is predicted to occur at the most impacted on-site locations. Corrosion of structures at these locations could be enhanced under conditions of heavy plant operation. Enhancement of ground-level fogging, icing, and precipitation is expected to be negligible for all conditions of plant use. Hazards to aircraft because of restricted visibility, turbulence, and icing of structures and engines are estimated to be very slight and of no consequence.

11843 **Tuning out transformer noise.** *EPRI J.*; **4**: No. 9, 24-25(Nov 1979).

Public complaints about the humming noise from transformers may be settled by a new, light-weight, inexpensive noise-reduction shell. Developed by the Electric Power Research Institute (EPRI) and Allis-Chalmers Corp., the shell is made of tuned panels which have met all the performance-testing criteria. The addition of a damping material to the shell was found to double the noise reduction to a combined level of 15 decibels. Transformer configuration will determine the cost savings for each installation.

THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 12535, 12688

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 11200, 12453

11844 (CRESS—49) **Evaluation of Radian's report, Water Pollution Impact of Controlling Sulfur Dioxide Emissions from Coal-Fired Steam Electric Generators.** Lee, S.S. (SRI International, Menlo Park, CA (USA)). Feb 1978. Contract EY-76-C-03-0115. 14p. Dep. NTIS, PC A02/MF A01.

SRI International is pleased to submit the following report, under DOE Master Agreement Number E(04-3)-115, to review, critique, and comment on the draft report entitled Water Pollution Impact of Controlling Sulfur Dioxide Emissions from Coal-Fired Steam Electric Generators, prepared by Radian Corporation. Our review is aimed at the following points: appropriateness of the assumptions; adequacy of the data base; and validity of conclusions and recommendations and their sensitivity to variations in assumptions and data. We agree that the water pollution impact of controlling sulfur dioxide is minimal. Removing SO/sub x/ from the gas phase will result in pollution problems in water and solid wastes. However, both water pollution and solid wastes are easier to handle (but that does not mean they are easier to treat). To meet the emission standards proposed by EPA, the removal rate of SO/sub x/ in scrubber or absorber systems is critical. In the Radian report, 90% removal is assumed in some calculations of water consumption. The assumption is reasonable and can be achieved; however, it should be considered an optimistic value. In actual practice, we believe an 80 to 85% removal rate is more realistic.

11845 (FE—3199-5) **Electron beam ionization for coal fly ash precipitators. Quarterly report, July 14-October 13, 1979.** Davis, R.H. (Florida State Univ., Tallahassee (USA)). 1979. Contract ET-78-S-01-3199. 23p. Dep. NTIS, PC A02/MF A01.

Completion of Task I was reported in the Annual Report. With this report Task II is complete. The objective of Task II was the quantitative measurement of the copious ionization produced by electron irradiation in a good geometry so that the results could be compared with the value expected from the stopping power relations established in nuclear physics and the specific ionization for air. The agreement is good. Since the ultimate objective is a field unit which will compete both in performance and cost with other alternatives, possible embodiments are considered as they are conceived. An embodiment based on the mobility differential between charged particles and molecular ions is discussed in the attached patent disclosure. It is too early to argue the economic advantages of such an embodiment but it appears to offer the advantage of a retrofit preionizer.

11846 (PB—290497) **EPA utility FGD (flue gas desulfurization): August-September 1978. Periodic report, August-September 1978.** Melia, M.; Smith, M.; Koger, T.; Laseke, B. (PEDCO-Environmental, Inc., Cincinnati, OH (USA)). Jan 1979. Contract EPA-68-02-2603. 154p. NTIS, PC A08/MF A01.

The report is an updated supplement to EPA-600/7-78-051a and should be used in conjunction with it. It presents a survey of utility flue gas desulfurization (FGD) systems in the U.S., summarizing information contributed by the utility industry, process suppliers, regulatory agencies, and consulting engineering firms. Systems are tabulated alphabetically, by development status (operational, under construction, in planning stages, or terminated operations), by utility company, by process supplier, by process, by waste disposal practice, and by regulatory class. It presents data on system design, fuel sulfur content, operating history, and actual performance. It discusses problems and solutions associated with the boilers and FGD systems. Process flow diagrams and FGD system economic data are appended to the report.

11847 (PB—290514) **Demonstration of Wellman-Lord/Allied Chemical FGD technology: acceptance test results.** Adams, R.C.; Lutz, S.J.; Mulligan, S.W. (TRW, Inc., Durham, NC (USA)). Jan 1979. Contract EPA-68-02-1877. 129p. NTIS, PC A07/MF A01.

The report gives results of acceptance tests of Wellman-Lord/Allied Chemical flue gas desulfurization (FGD) technology. Process performance guarantees were met or exceeded. During the 12-day Design Load test, the plant was operated at the design condition of a boiler flue gas output rate equivalent to 80% of the maximum boiler load of 115 MW gross. During the 83-hour High Load test, the plant treated flue gas volumes equivalent to 95% of maximum boiler load. SO2 removal of 90% or better was achieved. Particulate emissions did not exceed 0.1 lb/million Btu of boiler heat input. The consumption of steam, natural gas, and electrical power was less than the performance guarantee requirements at Design Load conditions. Soda ash consumption was less than the limit set by the performance guarantees. Finally, sulfur product purity was greater than 99.5%.

11848 (PB—292013) **Plume rise study at Johnsonville Steam Plant - data presentation.** Crawford, T.L.; Coleman, J.H. (Tennessee Valley Authority, Muscle Shoals, AL (USA). Div. of Environmental Planning). Jun 1978. 221p. NTIS, PC A10/MF A01.

This report makes detailed data on plume rise available for independent analysis by other specialists studying atmospheric dispersion. Techniques of data collection and methods of data reduction are detailed. Data from 90 time-averaged observations of the plume at Johnsonville Steam Plant, its source, and the meteorological conditions are reported. Most of the data were collected during midafternoon and are therefore characterized by unstable, neutral, and near-neutral conditions. The data are presented in both a summary and a detailed format.

11849 (PB—293875) **Demonstration/evaluation of the Cat-Ox flue gas desulfurization system. Final report, June 1970-October 1975.** Bee, R.; Reale, R.; Wallo, A. (Mitre Corp., McLean, VA (USA). METREK Div.). Mar 1978. Contract EPA-68-02-0650. 426p. NTIS, PC A19/MF A01.

The report gives a comprehensive summary of the experience gained and the problems encountered during the Cat-Ox demonstration program. The report outlines the process design and construction, as well as operating experience and problems. Test results and conclusions derived from baseline testing, acceptance testing, ESP testing, transient testing, and a number of special tests and studies associated with the system are reported.

11850 (PB—294042) **Fabric filter model format change; Volume II. User's guide. Final report November 1977-December 1978.** Dennis, R.; Klemm, H.A. (GCA Corp., Bedford, MA (USA). GCA Technology Div.). Feb 1979. Contract EPA-68-02-2607. 31p. NTIS, PC A03/MF A01.

The report describes an improved mathematical model for use by control personnel to determine the adequacy of existing or proposed filter systems designed to minimize coal fly ash emissions. Several time-saving steps have been introduced to facilitate model

application by Agency and other groups. To further aid the model user, the study is in two volumes: a detailed technical report and a user's guide. By using selected combustion, operating, and design parameters, the model user can forecast the expected emissions and filter pressure loss. The program affords the option of providing readily appraised summary performance statistics or highly detailed results. Several built-in error checks prevent the generation of useless data and avoid unnecessary computer time. The model takes into account the concentration and physical properties of the dust, air/cloth ratio, sequential compartmentized operation, and the method, intensity, and frequency of cleaning. The model function depends on the unique fabric cleaning and dust penetration properties observed with several coal fly ashes (including lignite) and woven glass fabrics.

11851 (PNL-SA—7021) **Impact of the proposed Atikokan electric generating facility on the wet deposition of sulfur in the Boundary Waters Canoe Area.** Scott, B.C. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1978. Contract EY-76-C-06-1830. 39p. Dep. NTIS, PC A03/MF A01.

The major impact of the Atikokan Power Plant on the Boundary Waters Canoe Area (BWCA) during precipitation will be related to the increased deposition of acidic sulfate which has been transformed during transit from the SO_2 source at Atikokan. The BWCA faces an equally serious impact due to the increased washout of SO_2 which, once in the surface waters, is likely to convert to an acidic sulfate. Both experimental data and theoretical models suggest that the wet deposition of sulfate from Atikokan will be seasonally dependent and will be related to features such as storm type, precipitation rate and concentration of sulfate being drawn into the storms. The concentration of SO_4 being drawn into the storms is dependent upon the rate of SO_2 conversion to sulfate during the transit from the source. Approximately 6 h will be required for emissions from Atikokan to reach the BWCA. During this time 10% or more of the SO_2 can be converted to SO_4. The highest wet deposition of sulfate is expected in the summer when summertime convective showers can remove 20 to 30 times the sulfate mass removed by wintertime snowstorms with the same precipitation intensity and duration. Procedures for determining wet deposition of both SO_4 and SO_2 are described. Estimates of the actual wet deposition associated with Atikokan, and predictions of precipitation acidity are presented. A general background discussion also presents the important concepts relating clouds and precipitation to the sulfate deposition at the ground.

11852 (SRI—9413) **Evaluation of Aerospace Corporation's report solid waste impact of controlling SO_2 emissions from coal-fired steam generators.** Clark, C.F. (SRI International, Menlo Park, CA (USA). Energy Center). Feb 1978. Contract EY-76-C-03-0115. 7p. Dep. NTIS, PC A02/MF A01.

Aerospace Corporation has prepared a report that estimates the future impact of changes in the New Source Performance Standards (NSPS) for SO_2 emissions on the amount of solid waste generated by various control methods. The US Department of Energy has requested that SRI International evaluate this report in the context of pertinence to the EPA Draft Standards of Performance for New Stationary Units - Electric Utility Steam Generating Units: appropriateness of the study assumptions; adequacy of the data base; and validity of results and conclusions. The assumptions about coal washing used in the report result in unrealistically low amounts of solid waste tailings being produced at the mine. Similarly, the amount of SO_2 sludge produced in the utility plant is low when using washed coal. As a result, the total amount of SO_2 sludge, plus the tailings produced when an emission level of 0.5 lb SO_2 per 10^6 Btu is achieved, appears to be lower than the amount produced under compliance with either the 1.2 lb SO_2 per 10^6 Btu or 90% removal standards. In addition, the economic and environmental impact of coal washing is not fully evaluated and included in the analysis. The assumptions used in the report for estimating solid waste disposal costs appear realistic. The disposal costs may vary from $2.70 to $13.10 per ton of dry solid waste from the 1000 MW plant, depending on the disposal method used; for the smaller capacity plants are considerably higher. The more stringent 90% SO_2 removal emission standard will strongly affect the development rate of western coals. The 90% SO_2 removal would require FGD in all locations, which would greatly reduce the incentive to move western coals to other parts of the United States.

SITE SELECTION AND LAND USE

REFER ALSO TO CITATION(S) 12001

POWER TRANSMISSION AND DISTRIBUTION

REFER ALSO TO CITATION(S) 11605, 11839, 11959, 12042

11853 (BNL—50178, pp 79-100) **Some heat-transfer and hydrodynamic problems associated with superconducting cables (CIIK-SPTL).** Hendricks, R.C. (National Aeronautics and Space Administration, Cleveland, OH); Daney, D.E.; Yeroshenko, V.M.; Kuznetsov, Ye.V.; Shevchenko, O.A. Aug 1979.

From 5. US/USSR symposium on superconducting power transmission; Upton, NY, USA (5 Sep 1978).

As the technology of superconducting power transmission lines advances, one must become more concerned with heat input to the coolant from the cable, the dielectric materials, and heat leaks and how these heat sources affect system hydrodynamics, including the refrigerator. Some results are presented of an experiment conducted at a USSR power institute in a heated, horizontal tube using fluid helium as the coolant. Stability problems of the coupled, liquifier-heated tube system are discussed, and some future experiments are proposed.

11854 Comments on propagation modes, equivalent circuits, and characteristic terminations for multiconductor transmission lines with inhomogeneous dielectrics. Sun, Y.Y. *IEEE Trans. Microwave Theory Tech.;* **MTT-26**: No. 11, 915-918(Nov 1978).

The correct expression of the characteristic admittance matrix of multiconductor transmission lines is recognized.

AC SYSTEMS, EHV AND UHV

11855 (CONS—3122-T1) **Field validation of cable monitoring and rating system (CMARS) laboratory model. First semi-annual report, 1 November 1978-30 April 1979.** Englehardt, J.; O'Neill, D.; Orifice, D.; Patton, R. (Public Service Electric and Gas Research Corp., Newark, NJ (USA)). 1979. Contract ET-78-C-01-3122. 119p. Dep. NTIS, PC A06/MF A01.

The goal of this project is to quantitatively validate the Cable Monitoring and Rating System (CMARS) software and associated hardware as applied to commercially operating underground transmission systems which are representative of the bulk of this type of system used in the USA. In the course of the project, it is expected that improvements and refinements of the CMARS will occur resulting in improved accuracy, flexibility and predictive capability for CMARS. The circuits to be utilized are equipped with extensive monitoring facilities, which will allow the determination of CMARS accuracy. In addition, recommendations will be made regarding accuracy vs. cost tradeoffs as a function of the amount and complexity of data which might be available on or retrofitted to existing systems, or considered for future systems. Information displays will be optimized by discussions with system operators, transmission planners and underground transmission engineering groups. Finally, hardware installation problems for sensor equipment as well as data acquisition equipment will be readily identified. At the completion of the proposed work, specifications for CMARS software and hardware, and all associated sensor, data acquisition and communications equipment will be available to the industry. The first semi-annual report on the project is presented.

DC SYSTEMS

REFER ALSO TO CITATION(S) 11858

11856 (PNL—2981) **Ozone field studies adjacent to a hvdc transmission test line.** Droppo, J.G.; Abbey, O.B.; Glover, D.W. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1979. Contract EY-76-C-06-1830. 135p. Dep. NTIS, PC A07/MF A01.

Field studies of atmospheric ozone concentrations adjacent to high voltage direct current (hvdc) transmission test lines were conducted at the Bonneville Power Administration's (BPA) hvdc Test Facility at The Dalles, Oregon. The transmission lines were operating at voltages from +- 400 to +- 600 kV during the field studies. The downwind ozone plumes were studied using a roving vertical profiling system. Ambient meteorological and test line parameters were also recorded to allow comparison of predicted and observed ozone plumes. For fair weather conditions no ozone plumes were evident. The absence of identifiable changes in ozone concentrations by the energized lines demonstrates the trivial nature of the ozone concentrations from the energized lines for fair weather conditions. Since corona loss from power lines is largest during precipitation, the ozone production is also largest. At the same time, the natural background atmospheric ozone concentrations are depressed by the scavenging effect of the precipitation. Therefore ozone production rates can best be measured during precipitation periods. With the exception of precipitation cases, the vertical profiles of ozone concentration demonstrated no discernible evidence of ozone plumes from the energized conductors. Ozone plumes, if any, were masked in the natural background ozone variability.

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

11857 (BNL—50178, pp 101-110) **Lapped insulation for a superconducting power transmission line.** Muller, A.C.; McNerney, A.J.;

Thomas, R.A.; Pearmain, A.J.; Kosaki, M. (Brookhaven National Lab., Upton, NY). Aug 1979.

From 5. US/USSR symposium on superconducting power transmission; Upton, NY, USA (5 Sep 1978).

A superconducting ac power transmission cable is under development at Brookhaven National Laboratory (BNL). The goal of this program is to develop an underground power transmission system suitable for transferring bulk quantities of electricity over distances of 16 to 160 km. The present goal of the BNL program is the construction of a 100 m outdoor three-phase ac cable rated at 138 kV and 1000 MVA. The refrigerator and the 100 m-long dewar are already installed. Terminations and cables are under design, and it is planned to begin installation of the first single phase cable in 1979. One fundamental phase of this project; the development of the required insulating materials, is described. The partial discharge characteristics of the insulating system will also be discussed.

11858 (BNL—50178, pp 111-126) **Recent progress in the Los Alamos program to develop dc superconducting power transmission systems.** Keller, W.E. (Los Alamos Scientific Lab., NM). Aug 1979.

From 5. US/USSR symposium on superconducting power transmission; Upton, NY, USA (5 Sep 1978).

Economic studies have showed that the Los Alamos Scientific Laboratory (LASL) dc superconducting power transmission line (dc SPTL) coaxial cable design could be advantageously applied to situations where single circuit power capacity greater than about 5000 MVA is required over distances greater than about 100 km. However, because it is desirable to provide dc SPTL circuit ratings of less than 5000 MVA, the LASL program has developed a small-line design as an alternate concept. Despite substantial differences between the coaxial and small-line designs, there are many similar requirements for developing the components of the two systems. A description of the small-line design and the rationale for its use are presented and several examples of recent progress in the major areas of the LASL dc SPTL program are reviewed.

11859 (BNL—51078) **Proceedings of the Fifth U.S.-U.S.S.R. Symposium on Superconducting Power Transmission.** Amoretty, S.J. (ed.). (Brookhaven National Lab., Upton, NY (USA)). Aug 1979. Contract EY-76-C-02-0016. 131p. (CONF-7809200—). Dep. NTIS, PC A07/MF A07.

From 5. US/USSR symposium on superconducting power transmission; Upton, NY, USA (5 Sep 1978).

Nine papers were presented at the meeting. A separate abstract was prepared for each paper. (LCL)

11860 (BNL—51078, pp 1-11) **Impulse dielectric strength of cold helium.** Levitov, V.I.; Goncharov, V.A.; Gosteyev, S.G.; Starovinsky, V.Ya. (Krzhizhanovsky Power Engineering Inst., Moscow, USSR). Aug 1979.

From 5. US/USSR symposium on superconducting power transmission; Upton, NY, USA (5 Sep 1978).

Experimental results of the impulse dielectric strength of helium at 4.2 to 20°K and pressures of 0.1 to 1 MPa in uniform and strongly nonuniform fields are given. The mechanism of cold-helium-impulse breakdown is discussed.

11861 (BNL—51078, pp 13-28) **Determination of the maximum temperature drop between the wall and the fluid with axial heat flux.** Blinkov, Y.L.; Guglina, L.L.; Bendik, N.T.; Smirnov, S.K. (Krzhizhanovsky Power Engineering Inst., Moscow, USSR). Aug 1979.

From 5. US/USSR symposium on superconducting power transmission; Upton, NY, USA (5 Sep 1978).

In the investigation of the current-carrying capacity of a superconducting cable, the overheating of the initial section of the core near the current lead must be calculated. The maximum overheating in the initial section of a cooled pipe at constant physical properties of the coolant for a laminar flow and given heat flux at the end of the pipe was determined. Two approaches to solve the problem are given: the conventional calculation of the temperature distribution using the heat-transfer coefficient and a new approach which takes into account the longitudinal heat conductivity at the wall and the thermal profile of the coolant at the beginning of the channel. The dependence of the overheating coefficient on the physical characteristics of the wall and the flux were calculated. The results are presented as dependences on the dimensionless criteria. The expression for the overheating coefficient are correlated and discussed.

11862 (BNL—51078, pp 29-36) **Experimental study of gas-cooled current leads for superconducting devices.** Belyakov, V.P.; Gorbachev, S.P.; Matyushchenkov, V.K.; Shifel'bain, A.G. (Cryogenmash, Moscow, USSR). Aug 1979.

From 5. US/USSR symposium on superconducting power transmission; Upton, NY, USA (5 Sep 1978).

Large superconducting systems, such as power transmission lines and superconducting magnets, need current leads with an independent flow of gas coolant. Although much attention has been devoted by different investigators to theoretical and computer studies of current leads, the number of experimental studies is extremely limited. Experimental work to compare test samples of current leads, which can be commercially produced and used in large, modern superconducting systems, is reported. Three types of current leads were tested. One type has a set of perforated copper plates which a superconducting Nb_3Sn tape is soldered. The second type was made from copper braids. The third type consisted of strands of 0.45 mm-dia wire. Two models of current conductors were tested at a current of up to 2 kA and one model at a current of up to 4 kA. The results showed that current leads with a self regulating gas coolant flow rate have a minimum heat flux of 0.92 W/kA; the axial heat flux along the current lead to the region of operating temperatures can be virtually eliminated; the current leads with braided tapes can be used to carry large currents, and the thermal characteristics of these current leads can be improved by distributing the current conductors more uniformly along the cross section of the current lead; and current leads made of strands of wires can be effectively used in a number of cases for transmission of current up to 1 to 2 kA. (LCL)

11863 (BNL—51078, pp 37-54) **Effect of the structural parameters of the current conductor of a superconducting cable on the topology of the magnetic field.** Dolgosheev, P.I.; Meshchanov, G.I.; Svalov, G.G. (All-Union Inst. of the Cable Industry, Podolsk, USSR). Aug 1979.

From 5. US/USSR symposium on superconducting power transmission; Upton, NY, USA (5 Sep 1978).

To provide flexibility in real superconducting power transmission cables with coaxial current conductors, the helical superconducting tapes must have butt spaces whose minimum width depends on the diameter of the conductors, on the width and pitch of the tapes, and on the minimum bending radius of the cable in the trench or on the drum. The width of the butt space 2c is usually about 0.5 to 1 mm. The butt spaces between the tapes produce a nonuniform three-dimensional magnetic field inside and outside of the helical tapes. The degree of nonuniformity of the magnetic field, the radial and azimuthal components of the magnetic field inside the layer of tapes, and the radial and axial components outside of it, which strongly depend on the ratio $s = 2c/2a$, where 2a is the width of the tape, increase with increasing parameter s, which increases the hysteretic losses in the superconductor and eddy current losses in the normal stabilizing metal. Equations are developed and used for estimating the effect of design parameters on the topography of the magnetic field of the superconducting cables current-carrying components. The analysis shows that for a superconducting cable having a current conductor made from a tape superconductor the value of s, which satisfies the required design with minimum losses, should be of the order of 0.08 to 0.09 for a no-load cable design and for a single-layer design. Using the equations presented the losses in the cable and their reduction as a result of changing the butt spaces between the tapes can be estimated. As the analysis shows, by selecting a value of 0.3 for the SPK-50 cable, the field components and hence the losses of the cable can be isolated. (LCL)

11864 (BNL—51078, pp 55-70) **Investigation of the hysteresis losses in Nb-Ti alloys and of the eddy current losses in high-purity aluminum.** Fisher, L.M.; Voloshin, I.F.; Dzugutov, V.M. Aug 1979.

From 5. US/USSR symposium on superconducting power transmission; Upton, NY, USA (5 Sep 1978).

Composite superconductors with a matrix made from normal metal with a high conductivity are usually used to obtain good thermal stability. The losses in the superconducting material consist of hysteresis losses in the superconductor and eddy-current losses in the stabilizing matrix. This work is devoted to the investigation of the hysteresis losses in the Nb-Ti alloys and the eddy-current losses in high purity aluminum at large amplitudes of the magnetic field. The work consists of two parts. Part A describes the results of the hysteresis loss measurements of Nb-Ti samples of different composition. Part B examines the electromagnetic properties of the eddy-current losses in high purity aluminum.

11865 (BNL—51078, pp 71-78) **Design of a heat exchanger for a cryogenic, vapor-cooled ac power lead.** Morgan, G.H. (Brookhaven National Lab., Upton, NY). Aug 1979.

From 5. US/USSR symposium on superconducting power transmission; Upton, NY, USA (5 Sep 1978).

A new design for vapor-cooled current leads for cryogenic equipment is described. This design uses an aluminum extrusion, bent into a tight coil and brazed together to form smultaneously both conductor and heat exchanger. The aluminum is commercial 1100 alloy, and a completed coil, including braze material, has a resistivity ratio RR = rho (273)/ rho (4.2) of 12.3. Aluminum is used to match the thermal expansion of the epoxy used for the high voltage dielectric, since the two materials must give a void-free bond over a large temperature range. Calculations used to optimize the design are explained. These calculations, based on real materials properties and standard correlations for heat transfer, show that the superconducting heat sink for a 61 cm long transition section made of 12.3 RR aluminum must be 28 cm long with a cross-section of 5.229 cm^2. It requires a gas flow at optimum current (4 kA) of 0.17146 g/sec. For

comparison, a hypothetical lead made of 20 RR copper would require a heat sink length of 42 cm and a cross-section of 2.2232 cm^2. It would require a gas flow at optimum current of .175893 g/sec. Leads having cross-sections optimized with shorter heat sinks require more coolant flow, have smaller cross-sections, and perform better with currents lower than optimum. Performance under overcurrent conditions is not as good with the short heat sinks. The calculations also show that a substantial error in heat sink length will result if the helium heat capacity is assumed constant.

NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 11313

11866 (INIS-mf—5198) **Energy for tomorrow - planning of today. No. 1.** Goergmaier, D.; Scholz, L.; Bayer, A.; Schmidtner, F.X.; Gottschlich, H.; Reiter, K.; Birkhofer, A.; Mansfeld, G.; Hofrichter, E.; Renn, O. (Bayerische Landeszentrale fuer Politische Bildungsarbeit, Muenchen (Germany, F.R.)). 1978. vp. (In German). Dep. NTIS (US Sales Only), PC A09/MF A01.

The present book, which has many maps and coloured illustrations, shows the many facets of the Federal Republic of Germany and EC energy policy. Apart from the fundamental problem of economic growth and future energy demand, present alternatives to nuclear power are presented and the limitations of primary energy carriers are pointed out. A team of twelve authors from science research, industry, and administrative authorities introduces the reader to all problems of nuclear power, from the basics of reactor functioning to reactor types, siting, and reactor technology. Problems of environmental protection (immission protection, avoiding water pollution and heat-up, local climate, etc.) are discussed in detail in the context of power generation from coal and nuclear energy.

11867 (INIS-mf—5210) **Report on Denmark's participation in the international cooperation on the peaceful uses of nuclear energy in the period May 1976 to December 1978.** (Energistyrelsen, Copenhagen (Denmark)). Mar 1979. 47p. (In Danish). Dep. NTIS (US Sales Only), PC A04/MF A01.

An outline of Denmark's participation in international nuclear energy cooperation May 1976-December 1978 is given.

11868 (INIS-mf—5215) **Netherlands Interuniversity Reactor Institut. Annual report for the Academic Year 1977-1978.** (Interuniversitair Reactor Inst., Delft (Netherlands)). 1978. 100p. (In Dutch). Dep. NTIS (US Sales Only), PC A06/MF A01.

This is the annual report of the Interuniversity Reactor Institute in the Netherlands for the Academic Year 1977-78. Activities of the general committee, the daily committee and the scientific advice board are presented. Detailed reports of the scientific studies performed are given under five subjects - radiation physics, reactor physics, radiation chemistry, radiochemistry and radiation hygiene and dosimetry. Summarised reports of the various industrial groups are also presented. Training and education, publications and reports, courses, visits and cooperation with other institutes in the area of scientific research are mentioned.

11869 (PNL-SA—6921) **Understanding public perspectives on nuclear energy.** Melber, B.D.; Rankin, W.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1978. Contract EY-76-C-06-1830. 31p. (CONF-780622—83). Dep. NTIS, PC A03/MF A01.

From ANS annual meeting; San Diego, CA, USA (18 Jun 1978).

The levels of and underlying bases for public support, opposition, and ambivalence toward continued nuclear power development are reviewed. Data are presented on the public's general evaluations of nuclear power by indicating the extent of support and opposition, by discussing the interpretation of undecided responses, and by examining changes in public opinion over time. Differences in general attitudes toward nuclear energy related to demographic characteristics, including sex, age, education, income, and geographic region are examined. Bases for explaining public support of and opposition to nuclear power are discussed by identifying consistent patterns of attitudes among pronuclear individuals and among antinuclear individuals in the general public.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 11898, 11926, 11930, 11931, 11936, 11938, 11946, 11950, 11952, 11955

11870 (COO—2985-33) **Oxygen suppression in boiling water reactors. Quarterly report 3, April 1-June 30, 1978.** Burley, E.L. (General Electric Co., San Jose, CA (USA). Nuclear Energy Engineering Div.). Dec 1978. Contract EY-76-C-02-2985. 92p. (NEDC—25856-2). Dep. NTIS, PC A05/MF A01.

Boiling water reactors (BWR's) generally use high purity, no-additive feedwater. The primary recirculating coolant is neutral pH and contains 100 to 300 ppB oxygen and stoichiometrically related dissolved hydrogen. However, oxygenated water increases austenitic stainless steel susceptibility to intergranular stress-corrosion cracking (IGSCC) when other requisite factors such as stress and sensitization are present. Thus, reduction or elimination of the oxygen in BWR water may preclude cracking incidents. This program is to perform an in-depth engineering evaluation of the potential suppression additives supported by critical experiments where required to resolve substantive uncertainties. On the basis of the engineering evaluation, the optimum oxygen suppression technique will be selected and a specific BWR plant recommended for an extended (3-year) plant demonstration experiment.

11871 (INIS-mf—5204) **Sharp folds at the bottom of pipe welds.** Thegerstroem, M.; Waahlstroem, L.E. (Sveriges Tekniska Kontrollinstitut AB, Stockholm (Sweden)). (Statens Kaernkraftinspektion, Stockholm (Sweden)). Jan 1979. 29p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

Welded joints in steam lines in the Forsmark 1 BWR reactor has been investigated. Folds were notised in the bottom of welds on both thin and thick pipes. It has been found that a high degree of precision in fabrication is important to avoid folds. This means good moulds, minimum displacement of edges and suitable velding technique. It is difficult to detect the folds. Radiography gives a poor result. Ultrasound is the most useful method. Sometimes testing with magnetic powder might be used. Calculations show that crack growth of the folds is very slow. A problem is the difficulty to determine the depth of the folds with nondestructive methods.

11872 (NUREG/CR—0675) **Test of 6-in.-thick pressure vessels. Series 3. Intermediate test vessel V-8.** Bryan, R.H.; Canonico, D.A.; Holz, P.P.; Iskander, S.K.; Merkle, J.G.; Smith, J.E.; Stelzman, W.J. (Oak Ridge National Lab., TN (USA)). Dec 1979. Contract W-7405-ENG-26. 232p. (ORNL/NUREG—58). Dep. NTIS, PC E05/MF E05.

Intermediate test vessel V-8, a 152-mm-thick vessel fabricated of SA 533, grade B, class 1 steel, was pressurized to failure at a test temperature of -23°C. The vessel contained a large fatigue-sharpened notch adjacent to a half-bead weld repair that had not been stress relieved. Residual stresses and fracture toughness were determined before the pressure test by measurements on a prototypic weld, and fracture predictions were made by linear elastic fracture mechanics. Predictions agreed well with results of the test, which demonstrated the important influence of high residual stresses on fracture behavior.

11873 (NUREG/CR—1011) **Steady-state axial pressure losses along the exterior of deformed fuel cladding: Multirod Burst Test (MRBT) bundles B-1 and B-2.** Mincey, J.F. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 209p. (ORNL/NUREG/TM—350). Dep. NTIS, PC A10/MF A01.

The experimental and COBRA-IV computational data presented in this report confirm that increased pressure losses, induced by the steady-state axial flow of water exterior to deformed Multirod Burst Test (MRBT) bundles B-1 and B-2, may be closely predicted using a bundle-averaged approach for describing flow channel restrictions. One anomaly that was encountered using this technique occurred while modeling the B-2 flow test data near a severe channel restriction: the COBRA-IV results tended to underestimate experimental pressure losses.

11874 (STUDSVIK/E2—78/35) **Mathematical model for the build up of corrosion products in water and on surfaces in BWR.** Aagaard, P.; Hermansson, H.P. (Studsvik Energiteknik AB, Nykoeping (Sweden)). Nov 1978. 26p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

In this report the division of a BWR-system into sections in which applicable parameters can be considered to be constant, is discussed. The BWR system is considered to be a coupled sequence of such sections. For each section linear differential equations which describe the transport of crud within the sections, have been written down. These equations form an equation system which describes the transport of crud within the whole BWR-system. Finally an account is given for five computer calculations in which the influence of crud-burster, temperature changes and carry-over-effects is analysed. The results indicate that the transport of crude is rather deeply dependent on the factors studied.

11875 (UCID—18142) **Technical evaluation of the proposed changes in the technical specifications for emergency power sources for the Big Rock Point nuclear power plant.** Latorre, V.R. (California

Univ., Livermore (USA). Lawrence Livermore Lab.). Dec 1979. Contract W-7405-ENG-48. 10p. Dep. NTIS, PC A02/MF A01.

The technical evaluation is presented for the proposed changes to the Technical Specifications for emergency power sources for the Big Rock Point nuclear power plant. The criteria used to evaluate the acceptability of the changes include those delineated in IEEE Std-308-1974, and IEEE Std-450-1975 as endorsed by US NRC Regulatory Guide 1.129.

11876 **Operating US power reactors.** Cottrell, W.B. (comp.). *Nucl. Saf.;* **20**: No. 6, 743-750(Nov 1979).

The operation of US power reactors during July and August 1979 is summarized. Events of special note are discussed and the operational performance of all licensed power reactors is presented.

11877 **Operating US power reactors.** Cottrell, W.B. (comp.). *Nucl. Saf.;* **20**: No. 5, 626-633(Sep 1979).

The operation of US power reactors during May and June 1979 is summarized. Events of special note are discussed, and the operational performance of all licensed power reactors is presented.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 11872, 11873, 11876, 11877, 11898, 11908, 11925, 11926, 11930, 11933, 11934, 11935, 11941, 11946, 11947, 11950, 11953, 11954, 11955

11878 **Oxidation of Zircaloy-4 at 900 and 1100°C in high pressure steam.** Pawel, R.E.; Cathcart, J.V.; Campbell, J.J. (Oak Ridge National Lab., TN (USA)). *J. Nucl. Mater.;* **82**: No. 1, 129-139(Jun 1979).

Oxidation experiments on Zircaloy-4 PWR tube specimens were conducted at 905 and 1101°C in flowing steam at pressures up to 10.34 MPa (1500 psi). Maximum exposure times were about 45 min at 905°C and 10 min at 1101°C. The growth characteristics of the oxide and oxygen-stabilized alpha layers after these exposures were examined and compared to those observed earlier for oxidation in steam at atmospheric pressure. At 1101°C, no differences in the growth rates of the layers were evident. However, the trend of the data at the lower oxidation temperature indicated that an increase in the rate of oxide layer growth does occur with increasing pressure. The magnitude of the observed effect on the oxide layer growth at 905°C was small for the reaction times studied and for pressures up to 6.9 MPa (1000 psi). For example, the maximum increase in oxide thickness observed at 6.9 MPa was less than 50% for times up to 30 min, and the kinetics continued to show negative deviations from ideal parabolic growth behavior. However, the few experiments at the highest pressure yielded oxide layer thicknesses approximately twice as thick as those anticipated for oxidation at atmospheric pressure. While a detailed mechanism is not apparent, metallographic examination of these oxide layers revealed that part of each layer was different structurally compared to that found for oxidation at atmospheric pressure. It is suggested that this difference is responsible for the increased growth rate of the oxide layer.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 11898, 11899, 11921, 12184

11879 (GA-A—14664) **One-fifth-scale fuel element column shake test. Final report.** Fischer, J.; Rakowski, J.E.; Olsen, B.E. (General Atomic Co., San Diego, CA (USA)). Sep 1979. Contract AT03-76ET35300. 105p. Dep. NTIS, PC A06/MF A01.

A series of seismic tests were performed on a one-fifth-scale HTGR fuel element column. The column was subjected to static deflections, free vibrations, and uniaxial and biaxial horizontal and vertical sinusoidal and earthquake time history excitations. Main parameters measured were column displacements and element impact forces, dowel forces, and rocking angles.

11880 (GA-A—15575) **Nuclear closed-cycle gas turbine (HTGR-GT): dry cooled commercial power plant studies.** McDonald, C.F.; Boland, C.R. (General Atomic Co., San Diego, CA (USA)). Nov 1979. Contract EY-76-C-03-0167-046. 17p. (CONF-800302—2). Dep. NTIS, PC A02/MF A01.

From 25. international gas turbine conference; New Orleans, LA, USA (9 Mar 1980).

Combining the modern and proven power conversion system of the closed-cycle gas turbine (CCGT) with an advanced high-temperature gas-cooled reactor (HTGR) results in a power plant well suited to projected utility needs into the 21st century. The gas turbine HTGR (HTGR-GT) power plant benefits are consistent with national energy goals, and the high power conversion efficiency potential satisfies increasingly important resource conservation demands. Established technology bases for the HTGR-GT are outlined, together with the extensive design and development program necessary to commercialize the nuclear CCGT plant for utility service in the 1990s. This paper outlines the most recent design studies by General Atomic for a dry-cooled commercial plant of 800 to 1200 MW(e) power, based on both non-intercooled and intercooled cycles, and discusses various primary system aspects. Details are given of the reactor turbine system (RTS) and on integrating the major power conversion components in the prestressed concrete reactor vessel.

11881 (GA-A—15614) **Turbomachinery design considerations for the nuclear HTGR-GT power plant.** McDonald, C.F.; Smith, M.J. (General Atomic Co., San Diego, CA (USA). Preliminary Design Dept.; United Technologies Corp., South Windsor, CT (USA). Power Systems Div.). Nov 1979. Contract EY-76-C-03-0167-046. 20p. (CONF-800302—3). Dep. NTIS, PC A02/MF A01.

From 25. international gas turbine conference; New Orleans, LA, USA (9 Mar 1980).

For several years, design studies have been under way in the USA on a nuclear closed-cycle gas turbine plant (HTGR-GT). Design aspects of the helium turbomachine portion of these studies are presented. Gas dynamic and mechanical design considerations are presented for helium turbomachines in the 400-MW(e) (non-intercooled) and 600-MW(e) (intercooled) power range. Design of the turbomachine is a key element in the overall power plant program effort, which is currently directed toward the selection of a reference HTGR-GT commercial plant configuration for the US utility market. A conservative design approach has been emphasized to provide maximum safety and durability. The studies presented for the integrated plant concept outline the necessary close working relationship between the reactor primary system and turbomachine designers.

11882 (INIS-mf—5216) **Social nuclear energy problems. The HTGR as a possible answer.** (Nederlands Inst. voor Vredesvraagstukken, The Hague). Oct 1978. 43p. (In Dutch). Dep. NTIS (US Sales Only), PC A03/MF A01.

It is thought that a comparatively new sort of reactor, the high temperature gas cooled reactor (HTGR), could remove, either for the whole or the greater part of, a number of points against the application of nuclear energy. This report therefore presses for a public study of the characteristics and properties of the HTGR and of the possibilities of its eventual application in the Netherlands. The first summary of the properties of the HTGR and the social consequences, should this reactor type be eventually introduced, are described. It is thought that the HTGR could form a basis for a compromise between those for and against nuclear energy.

11883 (Juel-Spez—21, pp 33-40) **Effects of nuclear process heat on the coal sector.** Messerschmidt, H. (Ruhrkohle A.G., Essen (Germany, F.R.)). Nov 1978. (In German).

From Information meeting of the KFA and its project partners on the high temperature reactor's state of development; Juelich, F.R. Germany (26 Sep 1978).

In nuclear coal gasification, HTR heat is coupled into the coal gasification process. The smaller amounts of coal used are a great economic advantage over autothermal gasification, which is clearly seen as the plants are used for layer periods. The development steps with regard to energy policy and time are illustrated by the example of the PNP project (Prototype plant for Nuclear Process Heat). Trend predictions are: In 2000, nuclear brown coal gasification plants will have a cost advantage already in their first year of operation. In brown coal and hard coal gasification, cost advantages are predicted for an operating time of 20 years.

11884 (ORNL/TM—6892) **HTGR experiment HRB-15b: particle loadings and irradiation in the High Flux Isotope Reactor.** Thomas, W.E.; Long, E.L. Jr.; Conlin, J.A.; Johnsen, B.P. (Oak Ridge National Lab., TN (USA)). Dec 1979. Contract W-7405-ENG-26. 73p. Dep. NTIS, PC A04/MF A01.

Candidate high-temperature gas-cooled reactor fissile and fertile particles were irradiated in the High Flux Isotope Reactor removable beryllium reflector facility (RB-5) for eight reactor cycles. The experiment contained 18 different "types" of fissile particles and five different "types" of fertile particles. All uranium was 20% enriched in ^{235}U. The loose particles were loaded into "trays" that resemble flat graphite washers, each having 116 drilled holes in one face. One hundred eighty-four trays were stacked in columns in an alternate fertile particle-fissile particle sequence. The particles were irradiated for 169.4 full power days. The report discusses methods used to specify particle loadings and contains thermal and neutronics results applicable to the irradiation test period.

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

REFER ALSO TO CITATION(S) 11911

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 11895, 11898, 11907, 11918, 11919, 11920, 11922, 11923, 11932, 11939, 11940, 11942, 12381

11885 (CONF-790902—, pp 116-127) **Experience with the conversion of the large-scale production code DIF3D to the CRAY-1.** Derstine, K.L. (Argonne National Lab., IL). 1979.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

Optimized iteration methods for the solution of large-scale fast reactor finite-difference steady-state neutron diffusion theory calculations are presented. The methods utilized include the Chebyshev semi-iterative method applied to accelerate the outer fission source iteration and an optimized block successive overrelaxation method for the within-group iterations. The theoretical basis and the computational and data management considerations that enter into the formulation of the overrelaxation method are discussed. A vectorized variant of the overrelaxation method is discussed. The conversion to the CRAY-1 of a computer code employing these methods is discussed, and the performance of vector and scalar algorithms on vector and sclar computers is compared for a benchmark problem. 3 tables.

11886 (COO—4932.M001-2) **Analysis of Flow Impedance Phenomena. Final report, June 1, 1978-July 31, 1979.** Bishop, A.A. (Pittsburgh Univ., PA (USA)). Dec 1979. Contract ET-78-S-02-4932. 102p. Dep. NTIS, PC A06/MF A01.

Pressure drop data obtained during testing of the MARK I, II and IIA fuel assemblies in the Argonne National Laboratory liquid metal core component loop (CCTL) were analyzed. It is concluded that the previously unexplained pressure drop increase measured across the MARK II and MARK IIA assemblies was caused by metallic particulate fouling; the source was mechanical-chemical wear of the loops pump journal shaft. The implication to liquid metal breeder reactor (LMFBR) operation is that if a continuous source of metallic particles exists upstream of the core, a pressure drop increase can be expected. The size of the deposited particles should be larger than the thickness of laminar sublayer on a fuel rod. It is also concluded that the most probable source of metallic particulates will come from component failure and not from normal corrosion products. A small amount of deposited particulates can produce a relatively high pressure drop increase.

11887 (DOE/TIC—11038) **Sodium hydride precipitation in sodium cold traps.** McPheeters, C.C.; Raue, D.J. (Argonne National Lab., IL (USA)). Oct 1979. Contract W-31-109-ENG-38. 29p. Dep. NTIS, PC A03/MF A01.

A series of experiments have been performed to test a calculational model for precipitation of NaH in sodium cold traps. The calculational model, called ACTMODEL, is a computer simulation that uses the system geometry and operating conditions as input to calculate a mass transfer coefficient and the distribution of NaH in a cold trap. The ACTMODEL was tested using an analytical cold trap (ACT) that is simple and essentially one-dimensional. The ACT flow and temperature profile may be controlled at any desired condition. The ACT was analyzed destructively after each test to measure the actual NaH distribution. Excellent agreement was obtained between the ACTMODEL simulations and the experiments.

11888 (DOE/TIC—11039) **Experiments on cold trap regeneration by NaH decomposition.** McPheeters, C.C.; Skladzien, S.B.; Raue, D.J. (Argonne National Lab., IL (USA)). Oct 1979. Contract W-31-109-ENG-38. 23p. Dep. NTIS, PC A02/MF A01.

Cold trap regeneration may be very important in future LMFBRs because of the expected high hydrogen source from the steam generators. This hydrogen precipitates as NaH in the cold trap and may fill the trap within one year of operation. Several methods of cold trap regeneration were considered, but the simplest and least expensive appears to be decomposition of NaH under vacuum at elevated temperatures. Experiments were done to assess the feasibility of this method for cold trap regeneration. Small-scale simulated cold traps (SCT) were located with NaH and NaH plus Na_2O, and were heated both under vacuum and under a sweep gas at 100 kPa. The evolved hydrogen was converted to water by a CuO bed and collected in a weighting tube.

11889 (GEFR-SP—191) **Corrosion issues in steam generators of the fast breeder reactor systems.** Spalaris, C.N. (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Dec 1979. Contract AT03-76SF70030. 16p. (CONF-800204—5). Dep. NTIS, PC A02/MF A01.

From Energy-sources technology conference; New Orleans, LA, USA (3 Feb 1980).

Reliability of sodium-heated steam generators is the key element to successful demonstration of Liquid Metal Fast Breeder Reactor. Corrosion resistance of the alloy selected for constructing the steam generators is paramount to high component reliability. A program was undertaken in th US to study the corrosion resistance of 2 1/4Cr-1Mo alloy, the reference construction material for the sodium heated steam generators. Test conditions selected for the experiments represent a wide spectrum of normal and faulted chemistry environments. The results obtained were used to establish (a) the basis for corrosion allowance in design, and (b) an understanding of temperature regimes, metallurgical condition and concentration of impurities that must be avoided in order to achieve high reliability of components. Experimental details, major findings, and significance of these to component reliability are reviewed in this paper.

11890 (JAPFNR—479) **Study on plan of mock-up critical experiment for large fast reactors by using the FCA. (Study on an amount of Pu fuel needed for partial mock-up experiment in large fast reactors).** Takano, H.; Mitani, H.; Matsui, Y.; Ishiguro, Y.; Kuroi, H. (Power Reactor and Nuclear Fuel Development Corp., Oarai (Japan); Japan Atomic Energy Research Inst., Tokyo). Jul 1979. 84p. (In English and Japanese). (PNC-SJ—250-79-18; JAERI-Memo—8362). Dep. NTIS (US Sales Only), PC A05/MF A01.

Work performed under United States—Japanese Fast Reactor Exchange Program.

Study on Pu-contents needed for partial mock-up experiment in large fast reactors was performed by considering zone loading, sector loading, and partial sum mock-up methods. Integral quantities, i.e., central reaction rate ratio, reaction rate distribution, Doppler reactivity coefficient, Na-void reactivity and control rod reactivity were calculated for full mock-up and these partial mock-up cores with various Pu-contents.

11891 (JAPFNR—482) **Out-of-pile experiment of fission gas release in LMFBR subassembly. 4. Feasibility study of gas release detection by use of flow fluctuation signal.** Inushima, H.; Ogino, T.; Ohkouchi, T.; Komaba, T.; Haga, K.; Hori, M. (Power Reactor and Nuclear Fuel Development Corp., Oarai, Ibaraki (Japan). Oarai Engineering Center; Mitsubishi Electric Corp., Amagasaki, Hyogo (Japan). Central Research Lab.). May 1979. 34p. (In English and Japanese). (PNC-N—941-79-49). Dep. NTIS (US Sales Only), PC A03/MF A01.

Work performed under United States-Japanese Fast Reactor Exchange Program.

Fission gas release tests were carried out in a 37-pin bundle to study the feasibility of fission product gas release detection by use of eddy current type flow meter. This 37-pin bundle simulated a normal subassembly of LMFBR. Flow and flow fluctuations were measured by an eddy-current type flow meter at the outlet of the bundle. The output signals from the flow meter were filtered and amplified through a specially made fluctuation measuring circuit. Thus, these measured signals were analyzed using a digital computer.

11892 (JAPFNR—488) **Investigation on neutronic performances of large scale heterogeneous LMFBR.** Iijima, S.; Yoshida, H.; Hotta, M. (Power Reactor and Nuclear Fuel Development Corp., Oarai (Japan); Japan Atomic Energy Research Inst., Tokyo). Apr 1979. 32p. (In English and Japanese). (JAERI-Memo—8266; PNC-J—250-79-14). Dep. NTIS (US Sales Only), PC A03/MF A01.

Work performed under United States—Japanese Fast Reactor Exchange Program.

Heterogeneous LMFBR concept with internal blanket has received substantial attention for its good breeding performance and fairly low sodium void reactivity effect. A comparative study of neutronic performances between conventional and heterogeneous LMFBRs has been made to identify what is the main issue in analyzing physics performance of heterogeneous LMFBR. The heterogeneous LMFBRs investigated in the study were Axial Parfait and Radial Heterogeneous LMFBRs with power 1000 MWe and the neutronic performances were burnup, breeding, power distribution, and sodium void reactivity effect. Uncertainty of the neutronic performances related to neutron cross-section data uncertainty was also examined in the study using three different 25-group cross-section sets generated from JAERI-FAST, ENDF/B-IV and JENDL-1.

11893 **Fast flux test facility ready to run.** Bliss, R.J.; Corrigan, D.C.; Peckinpaugh, C.L.; Squire, A. (Westinghouse Hanford Co., Richland, WA (USA)). *Nucl. Eng. Int.;* **24**: No. 208, 45-50(Jan 1979).

The FFTF reactor is described and design operating conditions are given. The various phases of the Acceptance Testing Programme are outlined and experiences associated with preoperational integrated leak rate testing, testing the heating and ventilating system, and initial filling with sodium of a secondary loop are

described. The programme for research and development in the FFTF reactor after February 1980 is outlined.

11894 (ORNL—5606) **Irradiated-Microsphere Gamma Analyzer (IMGA): an integrated system for HTGR coated particle fuel performance assessment.** Kania, M.J.; Valentine, K.H. (Oak Ridge National Lab., TN (USA)). Feb 1980. Contract W-7405-ENG-26. 48p. Dep. NTIS, PC A03/MF A01.

The Irradiated-Microsphere Gamma Analyzer (IMGA) System, designed and built at ORNL, provides the capability of making statistically accurate failure fraction measurements on irradiated HTGR coated particle fuel. The IMGA records the gamma-ray energy spectra from fuel particles and performs quantitative analyses on these spectra; then, using chemical and physical properties of the gamma emitters it makes a failed-nonfailed decision concerning the ability of the coatings to retain fission products. Actual retention characteristics for the coatings are determined by measuring activity ratios for certain gamma emitters such as $^{137}Cs/^{95}Zr$ and $^{144}Ce/^{95}Zr$ for metallic fission product retention and $^{134}Cs/^{137}Cs$ for an indirect measure of gaseous fission product retention. Data from IMGA (which can be put in the form of n failures observed in N examinations) can be accurately described by the binomial probability distribution model. Using this model, a mathematical relationship between IMGA data (n,N), failure fraction, and confidence level was developed. To determine failure fractions of less than or equal to 1% at confidence levels near 95%, this model dictates that from several hundred to several thousand particles must be examined. The automated particle handler of the IMGA system provides this capability. As a demonstration of failure fraction determination, fuel rod C-3-1 from the OF-2 irradiation capsule was analyzed and failure fraction statistics were applied. Results showed that at the 1% failure fraction level, with a 95% confidence level, the fissile particle batch could not meet requirements; however, the fertile particle exceeded these requirements for the given irradiation temperature and burnup.

REGULATION AND LICENSING

11895 (BNL—50831-4) **Design guide for category IV reactors: liquid metal reactors.** Brynda, W.J.; Karol, R.C.; Lobner, P.R.; Powell, R.W.; Straker, E.A. (Brookhaven National Lab., Upton, NY (USA)). Jul 1979. Contract EY-76-C-02-0016. 243p. Dep. NTIS, PC A11/MF A01.

The purpose of this Design Guide is to provide additional guidance to aid the DOE facility contractor in meeting the requirement that the siting, design, construction, modification, operation, maintenance, and decommissioning of DOE-owned reactors be in accordance with generally uniform standards, guides, and codes which are comparable to those applied to similar reactors licensed by the Nuclear Regulatory Commission (NRC). This Design Guide deals principally with the design and functional requirements of liquid metal cooled fast reactor (Category IV reactor) structures, components, and systems.

11896 (RDT-STATUS—(1-80)) **Summary of status of RDT standards.** (Department of Energy, Washington, DC (USA). Office of Nuclear Energy Programs). Jan 1980. Contract W-7405-ENG-26. 35p. RSO.

The January 1980 Status Report of RDT Standards is presented. This issue covers June through December 1979 since there was not an October issue. The next issue of the Status Report will be available in April 1980.

ECONOMICS

11897 **Nuclear and thermal power plants and the environment.** Mejstrik, V. (Ceskoslovenska Akademie Ved, Pruhonice. Ustav Krajinne Ekologie). *Radioaktiv. Zivotn. Prost.;* No. 4, 1-35(1978). (In Czech).

The growth is briefly outlined of world daily power consumption and the possibilities are discussed of meeting this demand. Coal and nuclear power are of primary importance as energy resources for the present and the near future. Production costs per 1 kWh of electric power in nuclear power plants are already lower than in fossil fuel power plants and both types of power plants have an environmental impact. Activities are presented of radioisotopes resulting from nuclear reactor operation and their release and environmental impact are discussed. An analysis is made of emissions from combustion processes and of wastes from fossil-fuel power plant operation. The environmental impacts of nuclear and fossil fuel power plants are compared.

CONSTRUCTION AND OPERATION

REFER ALSO TO CITATION(S) 12008

FUEL CYCLE

11898 (ORNL—5398(Exec.Summ.)) **Interim assessment of the denatured ^{233}U fuel cycle: feasibility and nonproliferation characteristics.** Abbott, L.S.; Bartine, D.E.; Burns, T.J. (eds.). (Oak Ridge National Lab., TN (USA)). Dec 1979. Contract W-7405-ENG-26. 74p. Dep. NTIS, PC A04/MF A01.

A fuel cycle that employs ^{233}U denatured with ^{238}U and mixed with thorium fertile material is examined with respect to its proliferation-resistance characteristics and its technical and economic feasibility. The rationale for considering the denatured ^{233}U fuel cycle is presented, and the impact of the denatured fuel on the performance of Light-Water Reactors, Spectral-Shift-Controlled Reactors, Gas-Cooled Reactors, Heavy-Water Reactors, and Fast Breeder Reactors is discussed. The scope of the R, D and D programs to commercialize these reactors and their associated fuel cycles is also summarized and the resource requirements and economics of denatured ^{233}U cycles are compared to those of the conventional Pu/U cycle. In addition, several nuclear power systems that employ denatured ^{233}U fuel and are based on the energy center concept are evaluated.

PROCESS HEAT REACTORS

REFER ALSO TO CITATION(S) 11077, 11883

11899 (GA-A—15611) **HTGR process heat program design and analysis. Final report, FY-79.** (General Atomic Co., San Diego, CA (USA)). Dec 1979. Contract AT03-76SF71061. 130p. Dep. NTIS, PC A07/MF A01.

This report summarizes the results of concept design studies at General Atomic Company during FY-79 for an 842-MW(t) Very High Temperature Reactor (VHTR) utilizing an intermediate helium heat transfer loop to provide thermal energy for the production of hydrogen or reducing gas (H_2 + CO) by steam-reforming of a light hydrocarbon. Basic carbon sources may be coal, residual oil, or oil shale. The report summarizes conceptual design tasks conducted on the prestressed concrete reactor vessel, thermal barrier, intermediate heat exchanger, reformer, and steam generator. The substantial completion of first generation programming for a performance/optimization code and the preparation of a topical safety report and other safety evaluation studies are reported. The completion of balance of plant criteria specifications and a balance of plant cost estimate is also reported.

NUCLEAR REACTOR TECHNOLOGY

THEORY AND CALCULATION

11900 (GA-A—15009(Vol.1)) **MICROX-2: an improved two-region flux spectrum code for the efficient calculation of group cross sections.** Mathews, D.; Koch, P. (General Atomic Co., San Diego, CA (USA)). Dec 1979. Contract AT03-76SF71023. 178p. Dep. NTIS, PC A09/MF A01.

The MICROX-2 code is an improved version of the MICROX code. The improvements allow MICROX-2 to be used for the efficient and rigorous preparation of broad group neutron cross sections for poorly moderated systems such as fast breeder reactors in addition to the well moderated thermal reactors for which MICROX was designed. MICROX-2 is an integral transport theory code which solves the neutron slowing down and thermalization equations on a detailed energy grid for two-region lattice cells. The fluxes in the two regions are coupled by transport corrected collision probabilities. The inner region may include two different types of grains (particles). Neutron leakage effects are treated by performing B_1 slowing down and P_0 plus DB^2 thermalization calculations in each region. Cell averaged diffusion coefficients are prepared with the Benoist cell homogenization prescription.

11901 (LA—8135-PR) **Transport and reactor theory, July 1-September 30, 1979.** Dudziak, D.J.; O'Dell, R.D.; Alcouffe, R.E. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 76p. Dep. NTIS, PC A05/MF A01.

Research and development progress in transport and reactor theory by the Los Alamos Scientific Laboratory's Group T-1 for the fourth quarter of FY 79 is reported. Included are tasks in the areas of Fission Reactor Neutronics Transport Methods Supporting Research, Reactor Safety Analysis, Fusion Reactor Nucleonics, Shielding Methods, and Safeguards Analysis.

11902 **Burnout in boiling heat transfer. Part III. High-quality forced-convection systems.** Bergles, A.E. (Iowa State Univ. of Science and Tech., Ames). *Nucl. Saf.;* 20: No. 6, 671-689(Nov 1979).

This is the final part of a review of burnout during boiling heat transfer. The status of burnout in high-quality forced-convection systems is reviewed, and recent developments are summarized in detail. A general guide to the considerable literature is given. Parametric effects and correlations for water in circular and noncircular ducts are presented. Other topics discussed include transients, steam-generator applications, correlations for other fluids, fouling, and augmentation.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 12182, 12210

11903 (DOE/TIC—11031) **Demonstration of a pattern recognition system at the HFIR.** Sides, W.H. Jr.; Piety, K.R. (Oak Ridge National Lab., TN (USA)). Aug 1979. Contract W-7405-EMG-26. 13p. Dep. NTIS, PC A02/MF A01.

The noise signals from the sensors in a system, such as a nuclear power plant, contain information concerning its current operating condition. Changes in these noise signals may reflect a change in operating condition. Interpretation of these changes may provide the operator with timely detection and diagnosis of anomalous conditions. A pattern recognition system was developed at ORNL to continuously monitor these noise signals on-line in unattended operation. The system was designed to provide a detailed record of the power spectral density values (PSDs) of the signals and their statistical characteristics. Through statistical comparison of current and past PSDs (pattern recognition), the system can detect changes in the noise signals. The system was demonstrated at the High Flux Isotope Reactor (GFIR) by continuously monitoring two neutron signals through four consecutive reactor fuel cycles from April through July 1979.

11904 (GA-A—15142) **Boundary value problems of the circular cylinders in the strain-gradient theory of linear elasticity.** Kao, B.G. (General Atomic Co., San Diego, CA (USA)). Nov 1979. Contract AT03-76ET35300. 43p. Dep. NTIS, PC A03/MF A01.

Three boundary value problems in the strain-gradient theory of linear elasticity are solved for circular cylinders. They are the twisting of circular cylinder, uniformly pressuring of concentric circular cylinder, and pure-bending of simply connected cylinder. The comparisons of these solutions with the solutions in classical elasticity and in couple-stress theory reveal the differences in the stress fields as well as the apparent stress fields due to the influences of the strain-gradient. These aspects of the strain-gradient theory could be important in modeling the failure behavior of structural materials.

11905 **Steam-generator tube performance: world experience with water-cooled nuclear power reactors during 1977.** Pathania, R.S.; Tatone, O.S. (Chalk River Nuclear Labs., Ontario). *Nucl. Saf.;* **20**: No. 5, 595-612(Sep 1979).

The performance of steam-generator tubes in water-cooled nuclear power reactors in various countries is reviewed for 1977. Tube failures were reported at 34 of the 79 reactors surveyed. The causes of these failures and the inspection and repair procedures designed to deal with them are presented. Although denting caused by corrosion remained the leading cause of tube failures, specific mechanisms have been identified, and methods of dealing with them have been developed. These methods are being applied and should lead to a reduction of corrosion failures in the future.

FUEL ELEMENTS

REFER ALSO TO CITATION(S) 12208

11906 **Characterization of irradiated nuclear fuels by precision gamma scanning.** Barnes, B.K.; Phillips, J.R.; Waterbury, G.R.; Quintana, J.N.; Netuschil, J.R.; Murray, A.S (Los Alamos Scientific Lab., NM (USA)). *J. Nucl. Mater.;* **81**: No. 1-2, 177-184(Apr 1979).

Gamma scanning is an important nondestructive technique for the characterization of irradiated fuel materials. Techniques and equipment for gross-gamma, isotopic, and two-dimensional scans are discussed. Applications to the determination of mechanical and structural information, neutron flux and burnup profiles, irradiation and cooling information, fission product migration data, and fuel pin failures are discussed.

CONTROL SYSTEMS

11907 (JAPFNR—494) **Studies of rare earth element as control rod material for LMFBR. Part V.** Suzuki, H.; Iseki, T.; Maruyama, T.; Ohno, A. (Tokyo Inst. of Tech. (Japan). Research Lab. of Nuclear Reactor). Apr 1979. 37p. (In Japanese). (PNC-J—261-79-02). Dep. NTIS (US Sales Only), PC A03/MF A01.

Work performed under United States—Japanese Fast Reactor Exchange Program.

Compatibility of Eu_2O_3 and a mixed oxide of $(Eu,Gd)_2O_3$ with Type 316 stainless steel was examined by heating sintered monoclinic Eu_2O_3 pellets and the mixed oxide of $(Eu,Gd)_2O_3$ pellets in contact with Type 316 stainless steel spacers. The heat-treatment was carried out in the range from 550°C to 1000°C for 500 h to 5000 h in out-of-pile conditions. The density of both Eu_2O_3 pellet and $(Eu,Gd)_2O_3$ pellet is approximately 95% of theoretical density. The ratio of number of Eu to Gd atoms contained in the mixed oxide of $(Eu,Gd)_2O_3$ is adjusted to be 1.0. Metallographic examination of the heat-treated stainless steel spacer indicated that chemical reaction between Eu_2O_3 and Type 316 stainless steel occurred at 650°C, and severe reaction, particularly grain boundary penetration, was observed in stainless steel sample which was heat-treated at 1000°C for 500 h.

11908 (UCID—18141) **Technical evaluation of the proposed deletion of a reactor trip on a turbine trip below 50-percent power for the Joseph M. Farley nuclear power plant.** Reeves, W.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Dec 1979. Contract W-7405-ENG-48. 10p. Dep. NTIS, PC A02/MF A01.

The Alabama Power Company's proposed license amendment for the deletion of a reactor trip on a turbine trip below 50% power for the Joseph M. Farley nuclear power plant is presented. This report is supplied as part of the Selected Electrical, Instrumentation, and Control Systems Issues Program being conducted for the US Nuclear Regulatory Commission by Lawrence Livermore Laboratory.

ENVIRONMENTAL ASPECTS

11909 (CONF-781108—, pp 66-89) **Statistical design and analysis of power plant entrainment studies.** Small, R.D.; Capizzi, T.; Sage, L.E. (Academy of Natural Sciences of Philadelphia, PA). Jul 1979.

From 4. DOE statistical symposium; Albuquerque, NM, USA (1 Nov 1978).

The main purpose of a power plant entrainment study is to obtain a precise estimate of the survival rate of entrained organisms. Statistical problems with the design and analysis of previous studies are discussed and a systematic sampling plan for a zooplankton entrainment study which alleviates most of these problems is presented. Time series and regression procedures are used to describe the periodic behavior of the zooplankton community and to obtain valid confidence intervals for the survival rate.

11910 **Unique ecological impacts associated with offshore floating nuclear power plants.** Adams, S.M.; McLean, R.B. (Oak Ridge National Lab., TN). *Nucl. Saf.;* **20**: No. 5, 582-591(Sep 1979).

The ecological impacts that could occur as a result of site construction and operation of an offshore floating nuclear power plant are identified by comparing the principal ecological features associated with offshore siting with those associated with the siting of onshore estuarine plants. In general, the ecological impacts of offshore nuclear plants should be relatively smaller than those of estuarine plants. Possible factors that could increase the relative impacts of offshore plants are high frequency of contact with schools of fish, siting near inlets to estuaries or other ecologically important areas, and the persistence of halogen residuals. Identifying the potential ecological impacts associated with the siting of offshore plants permits the development of various monitoring programs and measures to minimize these impacts.

SITING

REFER ALSO TO CITATION(S) 11927

RADIOACTIVE EFFLUENTS

REFER ALSO TO CITATION(S) 12500, 12533

CHEMICAL AND THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 12639

11911 (INIS-mf—5207) **Measurement and evaluation of thermal effects in the intermixing zone at low power nuclear station outfall.** Kamath, P.R.; Gurg, R.P.; Bhat, I.S.; Vyas, P.V. (Bhabha Atomic Research Centre, Bombay (India). Health Physics Div.). 1978. 8p. (CONF-781213—10). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Winter simulation conference; Miami Beach, FL, USA (4 Dec 1978).

Observations and evaluations of thermal effects in the lake near the RAPS-1 REACTOR, are reported. The coolant waters are drawn from the lake at a depth of 8-10 m below the surface and discharged through an open channel with a temperature rise of 10deg C. Temperature profiles and spread in the velocity of the outfall are mapped using in situ monitors. These studies show evidence of thermal stratification in the period following winter and the existence of a well established thermocline. Parasitism and eutrophication are also observed. The thermal effects are found to be accentuated by photosynthetic effects. Proposal to utilise waste heat for algal culture in the Kalpakkam nuclear site in South and mariculture (lobsters, prawns) in the heated effluents canal at the Tarapur Atomic Power Station near Bombay are discussed.

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 11943

11912 (HEDL-SA—1973-FP) **FFTF purification system performance during fill and initial temperature ascension.** Bloom, G.R. (Hanford Engineering Development Lab., Richland, WA (USA)). Oct 1979. Contract EY-76-C-14-2170. 24p. Dep. NTIS, PC A02/MF A01.

Design parameters of the sodium purification systems on the Fast Flux Test Facility are given. Sodium and argon cover gas impurity changes observed during initial sodium fill and initial reactor heatup to 800°F are discussed. Sodium Purification System operation during these critical sodium impurity control periods is described.

11913 (JAPFNR—484) **Neutron and gamma ray streaming experiments at the fast neutron source reactor YAYOI.** Oka, Y.; Yanagisawa, I.; Akiyama, M.; An, S. (Tokyo Univ. (Japan). Nuclear Engineering Research Lab.). Jul 1979. 75p. (PNC-J—260-79-01Tr). Dep. NTIS (US Sales Only), PC A04/MF A01.

Work performed under United States-Japanese Fast Reactor Exchange Program.

Neutron and gamma ray streaming experiments were performed in the ducts and cavities that were located in the heavy concrete shields of the fast neutron source reactor YAYOI of University of Tokyo. The configurations have the feature that the streaming through the ducts occurred following the scattering in the cavity. The axes of the ducts are perpendicular to the source radiation from the core. The spectrum of the source was modified by putting a plug in the beam hole of the core. An aluminum plug and the plug which contains paraffin were used. The decay in the ducts, however, hardly depends on the source spectrum. The decay in the ducts is nearly exponential.

11914 (ORNL/TM—7149) **Bulk shielding facility. Quarterly report, April, May, and June 1979.** Hurt, S.S.; Lance, E.D.; Thomas, J.R. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 30p. Dep. NTIS, PC A03/MF A01.

The BSR operated at an average power level of 1967 kW for 72.58% of the time during April, May, and June. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory. The BSR was operated at low and variable power during this quarter for 27.750 hours as part of the training programs for nuclear engineering students from the University of Tennessee. The PCA was also used in the above-mentioned training programs and was operated on one occasion when Mississippi State University students actively participated in training laboratories. The PCA was also operated on twenty-eight occasions for the Reactivity Determination using Spectra Density Measurements Experiment and on eighteen occasions for the Pressure Vessel Simulator Benchmark Experiment.

11915 **Determination of the neutron flux and energy spectrum in the low-temperature fast-neutron facility in CP-5, calculations of primary-recoil and damage-energy distributions, and comparisons with experiment.** Kirk, M.A.; Greenwood, L.R. (Argonne National Lab., IL (USA)). *J. Nucl. Mater.;* **80**: No. 1, 159-171(Mar 1979).

The authors have determined the absolute differential neutron-energy spectrum for the low-temperature fast-neutron irradiation facility in the CP-5 reactor by means of a 20-foil activation technique. This technique employs the most recent version of the SAND-II computer code, which iteratively unfolds the neutron spectrum by fitting the foil activities. A Monte Carlo routine was also employed to calculate standard-deviation errors in each neutron-energy group. Using this differential neutron spectrum the authors have calculated, for numerous elements, total recoil cross sections, detailed primary-recoil group distributions, total damage-energy cross sections, damage-energy distributions, and an error analysis based on the uncertainties in the neutron spectrum. The significance of this information with respect to the interpretation of various neutron radiation-damage experiments, including sputtering, disordering of ordered alloys, and changes in critical current of A-15 compound superconductors is discussed. A detailed comparison is made among initial resistivity damage rates for five widely different (well characterized) neutron sources, fission fragments, and heavy ions.

PLUTONIUM AND ISOTOPE PRODUCTION REACTORS

11916 (UNI-SA—67) **Microprocessor based flux wire evaluation and analysis system.** Peterson, D.G.; Toffer, H.; Sapp, S.P. (UNC Nuclear Industries, Inc., Richland, WA (USA)). 1980. Contract EY-76-C-06-1857. 18p. (CONF-800306—1). Dep. NTIS, PC A02/MF A01.

From International IECI conference; Philadelphia, PA, USA (17 Mar 1980).

A novel application of a microprocessor as the heart of a sophisticated data processing and analysis system at the Hanford N Reactor has been developed. Flux wires which map the neutron density distribution in the reactor are analyzed using the microprocessor system. Evaluation of flux wire activity is used to generate reactor operating limits and to monitor localized neutron flux depressions in the core.

REACTOR SAFETY

REFER ALSO TO CITATION(S) 11882, 12000, 12008

11917 (ANL—79-87) **Unavailability modeling and analysis of redundant safety systems.** Vaurio, J.K.; Sciaudone, D. (Argonne National Lab., IL (USA)). Oct 1979. Contract W-31-109-ENG-38. 109p. Dep. NTIS, PC A06/MF A01.

Analytical expressions have been developed to estimate the average unavailability of an m-out-of-n (m/n, $1 \leqq m \leqq n \leqq 4$) standby safety system of a nuclear power plant. The expressions take into account contributions made by testing, repair, equipment failure, human error, and different testing schemes. A computer code, ICARUS, has been written to incorporate these analytical equations. The code is capable of calculating the average unavailability, optimum test interval, and relative contributions of testing, repair, and random failures for any of three testing schemes. After verification of the methodology and coding in ICARUS, a typical auxiliary feedwater system of a nuclear power plant was analyzed. The results show that the failure modes associated with testing and true demands contribute considerably to the unavailability and that diesel generators are the most critical components contributing to the overall unavailability of the system.

11918 (CONF-781108—, pp 274-295) **Analysis of proposed transient overpower experiments.** Campbell, K. (Los Alamos Scientific Lab., NM); Hurd, D. Jul 1979.

From 4. DOE statistical symposium; Albuquerque, NM, USA (1 Nov 1978).

This problem presentation arose from a project to demonstrate a new approach to the assessment of risk associated with core-disruptive accidents in a liquid metal fast breeder reactor. The project is intended to anticipate problems that may arise when the results of a planned series of experiments are used in this context. A possible model and some simulated test results are presented.

11919 (DOE/TIC—11060) **SIEX design predictions for the PNC fuel pins in the HEDL P-E01 power-to-melt test.** (Hanford Engineering Development Lab., Richland, WA (USA)). 1979. Contract EY-76-C-14-2170. 13p. Dep. NTIS, PC A02/MF A01.

During the design phase of the HEDL P-E01 power-to-melt test, a series of design predictions were generated for the three PNC pins using the SIEX fuel pin modeling code. This document tabulates a series of selected PNC pin design predictions as requested by M. Shinohara during his visit to HEDL (October 8-19, 1979).

11920 **Depressurization of internally heated boiling pools.** Henry, R.E.; Smith, J.L.; Weber, J.T. (Argonne Natl Lab, Ill). *Am. Soc. Mech. Eng., [Pap.]*: No. 79-HT-101, 8(1979).

In assessing the behavior of molten fuel during hypothetical accident conditions, it is necesary to evaluate the behavior of boiling pools with internal heat generation under pressurized and blowdown (depressurization) conditions. In this experimental investigation, depressurization experiments were conducted with water in a transparent lucite vessel with various initial void fractions. Experiments were also carried out with bulk nucleation sites "seeded" in the liquid phase and with no such "seeding". The experiments show that with bulk nucleation sites the mixture maintains a homogeneous character during blowdown and essentially the entire liquid mass is vented during the depressurization. Without bulk nucleation sites,

there is significant drift of vapor through the liquid phase and considerably less liquid is vented during the transient. 5 refs.

11921 (GA-A—15606) **HTGR Generic Technology Program. Semiannual report for the period ending September 30, 1979.** (General Atomic Co., San Diego, CA (USA)). Nov 1979. Contract AT03-76ET35300. 439p. Dep. NTIS, PC A19/MF A01.

The technical accomplishments on the HTGR Generic Technology Program at General Atomic during the second half of FY-79 are reported. The report covers a period when the major design direction of the National HTGR Program is in the process of changing from the HTGR-SC emphasis to an HTGR-GT emphasis in the near term. The HTGR Generic Technology Program activities have been redirected to ensure that the tasks covered are supportive of this changing emphasis in HTGR applications. The activities include the need to develop an MEU fuel, and the need to qualify materials and components for the higher temperatures of the gas turbine plant.

11922 (HEDL-TME—79-39) **Interim report for the PINEX-2 transient test.** Porten, D.R.; Padilla, A. Jr.; Randklev, E.H. (Hanford Engineering Development Lab., Richland, WA (USA)). Sep 1979. Contract EY-76-C-14-2170. 174p. AT.

PINEX-2, the first international benchmark test performed as part of the TREAT/CABRI Exchange, was a dual-objective experiment to continue development of the Pinhole Imaging (PINEX) system for monitoring fuel motion, and to demonstrate the feasibility of internal fuel motion as a mechanism for mitigating the consequences of hypothetical LMFBR accidents. A special fuel pin with a pre-fabricated central hole in the fuel, insulator, and reflector was pre-irradiated in the General Electric Test Reactor and subjected to a $5/sec transient overpower excursion in the Transient Reactor Test (TREAT) Facility. Approximately 10 grams of molten fuel were ejected upward from the fuel region into the reflector and fission gas plenum.

11923 (IDO—1570-T31) **Investigation of optimal redundancy for a specific system objective.** Griffith, J.M.; Rasmuson, D.M. (EG and G Idaho, Inc., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 23p. Dep. NTIS, PC A02/MF A01.

Component redundancy is an effective technique for reducing system unavailability. However, the mathematical models relating redundance and unavailability are generally complex, and casual inspection does not reveal which components should be made redundant to reduce unavailability. This paper develops a method for determining which components are made redundant with the greatest concomitant unavailability reduction. The method was used to study three system designs. For each design it was possible to identify several components which could be made redundant with an associated reduction in unavailability. However, the method also demonstrated that making most components redundant does not reduce unavailability, and in one case a component redundancy actually increased unavailability. Application of the present method helps the designer develop insight concerning the role of component redundancy in a system design without complex calculations and interpretations. 6 figures, 1 table.

11924 **Cost-benefit comparison of nuclear and nonnuclear health and safety protective measures and regulations.** O'Donnell, E.P.; Mauro, J.J. (Ebasco Services, Inc., New York, NY). *Nucl. Saf.;* **20**: No. 5, 525-540(Sep 1979).

This article compares the costs and benefits of health and safety measures and regulations in the nuclear and nonnuclear fields. A cost-benefit methodology for nuclear safety concerns is presented and applied to existing nuclear plant engineered safety features. Comparisons in terms of investment costs to achieve reductions in mortality rates are then made between nuclear plant safety features and the protective measures and regulations associated with nonnuclear risks, particularly with coal-fired power plants. These comparisons reveal a marked inconsistency in the cost effectiveness of health and safety policy, in which nuclear regulatory policy requires much greater investments to reduce the risk of public mortality than is required in nonnuclear areas where reductions in mortality rates could be achieved at much lower cost. A specific example of regulatory disparity regarding gaseous effluent limits for nuclear and fossil-fuel power plants is presented. It is concluded that a consistent health and safety regulatory policy based on uniform risk and cost-benefit criteria should be adopted and that future proposed Nuclear Regulatory Commission regulatory requirements should be critically evaluated from a cost-benefit viewpoint.

11925 (NUREG/CR—0575) **PINSIM-MOD1: a nuclear fuel pin/electric fuel pin simulator transient analysis code.** Hagar, R.C.; Hedrick, R.A. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 241p. (ORNL/NUREG/TM—291). Dep. NTIS, PC A11/MF A01.

The PINSIM-MOD1 digital computer code has been developed for (1) simulating the thermal response of both nuclear fuel pins and electrically heated fuel pin simulators to reactor accident environments, (2) determining transient simulator power input, and (3) analyzing the results of simulator experiments. The code is capable of simulating the thermal response of up to four pins and their associated coolant channels. Three interrelated power systems are modeled in the code, which is capable of determining the power for these systems by interpolating user-supplied tables, by solving the point reactor kinetics equations with or without reactivity feedback, by back-calculation from desired pin surface conditions, or by determining the second-order transfer function response to a calculated demand.

11926 (NUREG/CR—0970) **Qualification Testing Evaluation Program: light water reactor safety research. Quarterly report, January-March 1979.** Bonzon, L.L.; Clough, R.L.; Salazar, E.A. (Sandia Labs., Albuquerque, NM (USA)). Nov 1979. Contract EY-76-C-04-0789. 48p. (SAND—79-1314). Dep. NTIS, PC A03/MF A01.

New initiatives were outlined in two areas. Suggested under Task 1 was an approach to provide data related to accident testing methodology for safety-related electrical cable. This approach has two main objectives: to provide experimental data and analyses of current acceptance criteria for loss-of-coolant accident (LOCA) and main steam line break (MSLB) testing of safety-related electrical cable and, if necessary, to further define or develop acceptance criteria for performance indicators that are shown to be important and for which specific criteria are not provided in existing standards; and to formulate an acceptable and practical comprehensive test methodology that can be utilized for LOCA and MSLB testing of electrical cables including guidance on test specimen, test chamber, and test procedures. Under Task 3, it was proposed that test plans be developed to extend the accelerated aging effort to include gaskets and seals.

11927 (NUREG/CR—1120) **Seismic Safety Margins Research Program (Phase I). Quarterly progress report No. 5.** Bailey, R.D. (comp.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Oct 1979. Contract W-7405-ENG-48. 79p. Dep. NTIS, PC A05/MF A01.

This document is a quarterly progress report on the Seismic Safety Margins Research Program (SSMRP). The report gives a general description of the program, together with financial summaries and individual project details. Each project is summarized to show accomplishments, schedules, milestones and completion dates, budget and expenditures, and any concerns that may affect the project.

11928 (PB—293817) **Seismic design decision analysis. Nuclear power plants and the operating basis earthquake - Phase I.** Schumacker, B. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Civil Engineering). Jan 1975. 10p. NTIS, PC A02/MF A01.

Nuclear power plants are affected by two earthquake levels in their design and operation: the safe shutdown earthquake (SSE) and the operating basis earthquake (OBE). This study is concerned solely with the OBE and the probability that a plant, two plants simultaneously, or generally that n plants simultaneously will have to shutdown for inspection during the next Y years. The study is not concerned with structural response, but solely with the question of whether shutdowns for inspection will be required. This report describes the first phase of this study which looked at an area comprised of three seismic source zones and nine nuclear power plants. The location of the plants were considered to be: Wiscasset, Maine; Seabrook, New Hampshire; Vernon, Vermont; Rowe, Massachusetts; Plymouth, Massachusetts; Charlestown, Rhode Island; Waterford, Connecticut; Haddam, Connecticut; and Shoreham, Long Island. The OBE was taken as a modified Mercalli intensity VI for each plant, even though this may not be the actual situation. Differences in plant capacity were ignored in this initial study. A computer program developed in Russia at the Institute of Geophysics for damage and loss studies was used to compute the effect of an earthquake on these sites. The assumptions used in the description of the seismicity of the region are described in this report. The results from this phase of the study are presented.

11929 (PB—293938) **Multiple failure risk of spatially distributed structures. Seismic design decision analysis. Internal study report.** Taleb-Agha, G.; Hein, K. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Civil Engineering). Feb 1975. 17p. NTIS, PC A02/MF A01.

The problem being considered in this report is the following: given a set of N sites, each with an associated critical level of earthquake intensity (which may, for example, be a threshold intensity of damage), what is the probability of simultaneously equaling or exceeding any q out of the N intensities within a specified period of time. The method developed is applied to a hypothetical problem which illustrates the possible application to a real problem. It is presumed that in New England there are nine nuclear power plants. These nine are either already in operation or under construction or in initial stages of design. The operating basis earthquake intensity for these plants is considered to be M.M.I. VI, which corresponds to an acceleration of 31.6 cm/second squared. For the region consid-

ered there are three seismically active areas, and a seismically active background area. This is the same problem treated in Internal Study Report Number 51, which uses a computer program developed in Russia. The results from the present study with those in Internal Study Report Number 51 are compared. The comparison involves the intensity approach and firm soil. In a general sense, the two sets of results are within the same range of order of magnitude.

11930 (STUDSVIK/E2—78/12) **Study of the release of fission products from the fuel elements at a core meltdown in a LWR and the transport of the elements in the reactor vessel and in the containment.** Carlson, F. (Studsvik Energiteknik AB, Nykoeping (Sweden)). Oct 1978. 110p. (In Swedish). Dep. NTIS (US Sales Only), PC A06/MF A01.

The aim of the work was to define the factors which are most important for the release of radioactivity from the fuel elements in a LWR at a loss of coolant accident and for the transport of this activity to the environment. It was found that the knowledge about some of these factors is rather poor. However extensive research projects are in progress in this field particularly in the USA and The federal republic of Germany.

11931 (STUDSVIK/E4—78/64) **BWR emergency core cooling investigations. Spray cooling heat transfer experiment in a full scale BWR bundle mock-up. DSF project no 1.** Eriksson, S.O.; Harju, R.; Pettersson, R. (Studsvik Energiteknik AB, Nykoeping (Sweden)). Oct 1978. 288p. Dep. NTIS (US Sales Only), PC A13/MF A01.

This report describes the Dsf-P1 project Spray Cooling Heat Transfer Experiment in a BWR Bundle mock-up. It gives the philosophy behind the choice of test parameters which covered very extreme conservative assumptions for reactor application. The global influence of the test parameters on the rod cladding temperature is shown and comparisons between channel rewetting data and predictions are presented. When the test program was completed and the bundle dismantled, a severe bundle distortion was revealed. The originally planned evaluation of heat transfer coefficients was therefore limited to a very preliminary analysis. This report recommends a separate project with the purpose to perform a detailed mapping of the bundle distortion and to evaluate heat transfer coefficients.

11932 Flow behavior of volume-heated boiling pools: implications with respect to transition phase accident conditions. Ginsberg, T. (Brookhaven National Lab., Upton, NY); Jones, O.C. Jr.; Chen, J.C. *Nucl. Technol.;* **46**: No. 3, 391-398(Dec 1979).

Observations of two-phase flow fields in single-component volume-heated boiling pools were made. Photographic observations, together with pool-average void fraction measurements, indicate that the churn-turbulent flow regime is stable for superficial vapor velocities up to nearly five times the Kutateladze dispersal limit. Within this range of conditions, a churn-turbulent drift flux model provides a reasonable prediction of the pool-average void fraction data. An extrapolation of the data to transition phase accident conditions suggests that intense boilup could occur where the pool-average void fraction would be >0.6 for steel vaporization rates equivalent to power levels $>1\%$ of nominal liquid-metal fast breeder reactor power density. The extended stability of bubbly flow to unusually large vapor fluxes and void fractions, observed in some experiments, is a major unresolved issue.

11933 Fission product source terms for the light water reactor loss-of-coolant accident. Lorenz, R.A.; Collins, J.L.; Malinauskas, A.P. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **46**: No. 3, 404-410(Dec 1979).

Models for cesium and iodine release from light water reactor (LWR) fuel rods defected in steam were formulated based on experimental fission product release data from several types of defected LWR fuel rods. The models were applied to a pressurized water reactor undergoing a loss-of-coolant accident temperature transient. Calculated total iodine and cesium releases were 0.053 and 0.025% of the total reactor inventories of these elements, respectively, with most of the release occurring at the time of rupture. These values are approximately two orders of magnitude less than those used in WASH-1400, the Reactor Safety Study.

11934 TRAC analysis of loss-of-fluid test non-nuclear test L1-4. Pyun, J.J.; Williams, K.A. (Los Alamos Scientific Lab., NM). *Nucl. Technol.;* **46**: No. 3, 411-421(Dec 1979).

The Transient Reactor Analysis Code (TRAC) is being developed at the Los Alamos Scientific Laboratory as an advanced best-estimate computer program for analyses of postulated accidents in light water reactors. As a part of the TRAC verification effort, a posttest analysis of loss-of-fluid test (LOFT) non-nuclear test L1-4 has been conducted. The results of this analysis show that TRAC accurately predicts the thermal-hydraulic response of the entire LOFT system, including the delayed effects from emergency core coolant injection into the cold leg.

11935 Analysis of a simulated small break in the semiscale system under loss-of-coolant accident conditions. Cartmill, C.E. (EG and G Idaho, Inc., Idaho Falls). *Nucl. Technol.;* **46**: No. 3, 422-427(Dec 1979).

A Semiscale Mod-1 blowdown heat transfer test was conducted to supply thermal-hydraulic data concerning the fluid phenomena that occur during a small break loss-of-coolant accident. While it is easily recognized that a large break suddenly releases a great volume of coolant with rapidly falling levels and pressures, emergency core injection will also occur very early, compared to a small break. There has been concern that the longer times involved in small breaks (much longer subcooled flow periods) could lead to effects worse than for large breaks. Within the scope of the testing conducted, the small break has proven to be of lower consequences than the large break.

11936 Vent clearing during a simulated loss-of-coolant accident in a Mark I boiling water reactor pressure-suppression system. Pitts, J.H.; McCauley, E.W. (Univ. of California, Livermore). *Nucl. Technol.;* **46**: No. 3, 433-441(Dec 1979).

The response of the pressure-suppression containment system of Mark I boiling water reactors to a large break, design basis loss-of-coolant accident was examined on a 1/5-scale experimental facility. A logical interrelationship between measured forces, measured pressures, and the hydrodynamic phenomena (observed with high-speed cameras) is established. Peak downward forces on the wetwell occur at about the time of vent clearing. Peak upward forces occur shortly before bubble breakthrough. Quantitative values of forces and pressures from our 1/5-scale experiment, at times up to and including the peak download, can be applied to full-scale plants using established scaling laws. Only qualitative relationships to full-scale plants are determined at later times, because substantial quantities of steam (not simulated in our 1/5-scale experiment) would have entered the wetwell.

11937 Fuel-coolant interactions in a shock tube geometry. Segev, A. (Battelle Columbus Labs., OH); Henry, R.E.; Bankoff, S.G. *Nucl. Technol.;* **46**: No. 3, 482-492(Dec 1979).

Shock tube experiments with a variety of liquids have been conducted in which large pressures were obtained for systems of water-Wood's metal, butanol-Wood's metal, and water-molten salt. With the water-Wood's metal system, three separate regions were observed. When the hot liquid temperature was below 210°C (which can be identified as the spontaneous nucleation temperature), no thermal interaction occurred, and the cold liquid column only bounced if vapor were present initially (region A). When the hot liquid temperature was greater than the spontaneous nucleation temperature but the contact interface temperature was less than this value (region B), the low rate of vaporization resulted in bouncing of the liquid column, which in turn produced high pressures on the order of the theoretical water hammer pressure. Those hydrodynamic pressures are larger than the vapor pressure corresponding to the bulk temperature of the hot liquid and larger than the maximum pressure that may be generated from single-phase pressurization. The third region, observed when the hot liquid temperature was above the spontaneous nucleation temperature upon contact (region C), resulted in fast production of vapor and impulses larger than the theoretical impulse for stopping the liquid column. The mechanism for producing the high pressures in region C is a combination of hydrodynamic impact and thermal interaction. Since pressures produced in region C are also on the order of impact pressures, the only indication for thermal interaction is a considerable increase in the resulting impulse of pressure pulses with short rise time (<1.0 ms).

11938 Higher order effects in calculating boiling water reactor Doppler and void reactivity feedback. Diamond, D.J.; Cheng, H.S. (Brookhaven National Lab., Upton, NY). *Nucl. Technol.;* **46**: No. 3, 493-499(Dec 1979).

The effect of steam voids and control rods on the Doppler feedback and of bypass voids on the total void feedback has been calculated for a gadolinia-shimmed boiling water reactor. Calculations were done using a point model, i.e., feedback was expressed in terms of reactivity coefficients determined for individual four-bundle configurations and then appropriately combined to yield reactor results. For overpower transients, the inclusion of the void effect will make the Doppler feedback stronger. The effect of control rods is to reduce Doppler feedback. For overpressurization transients, the inclusion of the effect of bypass void will increase the reactivity due to void collapse.

11939 Critical experimental study of integral physics parameters in simulated liquid-metal fast breeder reactor meltdown cores. Bhattacharyya, S.K.; Wade, D.C.; Bucher, R.G.; Smith, D.M.; McKnight, R.D.; LeSage, L.C. (Argonne National Lab., IL). *Nucl. Technol.;* **46**: No. 3, 517-524(Dec 1979).

Integral physics parameters of several representative, idealized meltdown liquid-metal fat breeder reactor (LMFBR) configurations were measured in mockup critical assemblies on the Zero Power Reactor 9 at Argonne National Laboratory. The experiments were designed to provide data for the validation of analytical methods used in the neutronics part of LMFBR accident analyses.

Large core distortions were introduced in these experiments (involving 18.5% core volume), and the reactivity worths of configuration changes were determined. The neutronics parameters measured in the various configurations showed large changes on core distortion. Both diffusion theory and transport theory methods were shown to mispredict the experimental configuration eigenvalues. In addition, diffusion theory methods were shown to result in a nonconservative misprediction of the experimental configuration change worths.

11940 Low sodium void cores. Barthold, W.P.; Beitel, J.C.; Lam, P.S.K.; Orechwa, Y.; Su, S.F.; Turski, R.B. (Argonne National Lab., IL). *Nucl. Technol.;* **46**: No. 3, 525-528(Dec 1979).

To avoid high energy releases in unprotected loss-of-flow accidents, cores can be designed such that the removal of sodium would add only a small amount of reactivity or even a negative reactivity to the reactor. Reduction in sodium void reactivity can be achieved by changing either the geometry or composition of the core. Pancake, modular, and heterogeneous core configurations were investigated. Heterogeneous cores showed sodium void reactivities in the 2-dollar range with only small penalties in doubling time when compared with the equivalent homogeneous cores. Liquid-metal fast breeder reactors using U-Th fuel in the form of metal, oxide, or carbide show negative sodium void reactivities but doubling times above 30 yr.

11941 Radioactivity release versus probability for a steam generator tube rupture accident. Buslik, A.J.; Hall, R.E. (Brookhaven National Lab., Upton, NY). *Nucl. Technol.;* **46**: No. 3, 566-570(Dec 1979).

A calculation of the probability distributions for the radioactive releases of ^{131}I and ^{133}Xe in a steam generator tube rupture accident is given; the effects of iodine spiking are included. The accident sequence considered involves loss of off-site power after the steam generator tube rupture. Two models are considered for iodine release, one of which yields upper bound releases, and the other of which is our best-estimate model. With the best-estimate model, the probability of a ^{131}I release >2 Ci is 1×10^{-6} per reactor-year. With the upper bound model, the probability of a ^{131}I release >66 Ci is 1×10^{-6} per reactor-year. The probability of a release exceeding 600 Ci of ^{133}Xe is 2×10^{-6} per reactor-year.

11942 Fuel pins and core response under liquid-metal fast breeder reactor transient overpower accident conditions. Wilburn, N.P.; Smith, D.E.; Baars, R.E.; Atcheson, D.B.; Spencer, B.W. (Hanford Engineering Development Lab., Richland, WA). *Nucl. Technol.;* **46**: No. 3, 591-599(Dec 1979).

Since the earlier liquid-metal fast breeder reactor transient overpower assessments were done (1975), new experimental data and modeling improvements have occurred that indicate later failures and more molten fuel squirted into the channel with a higher propensity for plugging. An initial sweepout still occurs, and an analysis shows that even if coherent instead of the expected stochastic failures occur, the blockages are partial, the reactor is strongly shut down, and a coolable geometry exists. Hence, the overall consequences would be benign.

11943 Analysis of transient overpower accidents in the Fast Test Reactor using the Los Alamos Failure Model. Mast, P.K.; Scott, J.H. (Los Alamos Scientific Lab., NM). *Nucl. Technol.;* **46**: No. 3, 600-605(Dec 1979).

A new fuel pin failure model, the Los Alamos Failure Model (LAFM), based on a linear life fraction rule failure criterion, has been developed to provide a reliable and inexpensive prediction of the time and axial location of liquid-metal fast breeder reactor fuel pin failure in a hypothetical transient overpower (TOP) accident. Code testing analyses for a number of TOP Transient Reactor Test Facility tests have resulted in excellent agreement between calculated and observed pin failure time and location. Because of the nature of the failure criterion used, the code has also been used to investigate the extent of cladding damage incurred in terminated as well as unterminated TOP transients in the Fast Test Reactor. The results of these analyses show that 3 dollar/s and 50 and 5 cent/s transients terminated by the secondary trip point (25% overpower) result in negligible calculated cladding damage.

11944 Risks associated with nuclear power. *Nucl. Saf.;* **20**: No. 6, 664-670(Nov 1979).

The report from which this article is adapted is a critical review of the literature pertaining to the risks associated with nuclear electric power. The review was sponsored by the Committee on Science and Public Policy of the National Academy of Sciences. This article presents highlights from the Summary and Synthesis Chapter which was released separately.

11945 Assessment of the frequency of failure to scram in light-water reactors. Apostolakis, G. (Univ. of California, Los Angeles); Kaplan, S.; Garrick, B.J.; Dickter, W. *Nucl. Saf.;* **20**: No. 6, 690-705(Nov 1979).

Bayesian methods are used to construct a distribution for the probability of failure of the reactor protection system (RPS) per demand inlight-water reactors. This distribution expresses quantitatively the current state of knowledge as formed by analysis of the RPS, by the available statistical evidence, and by the work of the Electric Power Research Institute, and the Nuclear Regulatory Commission staff on anticipated transients without scram. The distribution can be summarized by the following values: 5th percentile: 6×10^{-6} per demand; median: 2.8×10^{-5} per demand; mean: 5.4×10^{-5} per demand; 95th percentile: 1.2×10^{-4} per demand.

11946 Stress-corrosion cracking in piping of light-water-reactor plants. *Nucl. Saf.;* **20**: No. 6, 729-734(Nov 1979).

The Pipe Crack Study Group, established by the Nuclear Regulatory Commission (NRC), reviewed intergranular stress-corrosion cracking (IGSCC) of piping in boiling-water reactors (BWRs) and in 1975 issued a report, NUREG-75/067. During 1978 such cracking was reported for the first time in large-diameter piping (> 20 in.) in a BWR in the Federal Republic of Germany. This discovery, together with the reported questions concerning the interpretation of ultrasonic inspections, led to the establishment of a new Pipe Crack Study Group by the NRC. The charter of the new group was expanded to include (1) a review of the potential for stress-corrosion cracking in pressurized-water reactors (PWRs) as well as in BWRs, (2) an examination of the operating experience in foreign reactors relevant to IGSCC, and (3) a response to five specific questions concerning IGSCC. This article summarizes the findings of the new Pipe Crack Study Group; complete details are presented in their report, NUREG-0531.

11947 Summary of TMI-2 Lessons Learned Task Force report. *Nucl. Saf.;* **20**: No. 6, 735-741(Nov 1979).

After its review of the Three Mile Island 2 accident, the TMI-2 Lessons Learned Task Force recommended that a number of actions in the areas of design and analysis and plant operations be required in the short term to provide substantial additional protection for the public health and safety. All nuclear power plants in operation or in various stages of construction or licensing action are affected to varying degrees by the specific recommendations. Comments by the Advisory Committee on Reactor Safeguards concerning the short-term recommendations are presented.

11948 Events resulting in reactor shutdown and their causes. Scott, R.L.; Gallaher, R.B. (comps.). *Nucl. Saf.;* **20**: No. 6, 741-742(Nov 1979).

The licensee event reports (LERs) that were received during July and August 1979, were reviewed, and those events which involved a reactor shutdown are listed.

11949 System reliability engineering methodology: a discussion of the state of the art. Fussell, J.B. (Univ. of Tennessee, Knoxville); Arendt, J.S. *Nucl. Saf.;* **20**: No. 5, 541-550(Sep 1979).

The system reliability engineering methodology that is in general use for nuclear systems applications is discussed. No effort is made to address the present state of theoretical development; the approaches covered are those which have been tested by extensive application. Since nuclear systems reliability engineering frequently involves too much information for manual processing techniques, this article lists some of the available computer programs that can be used to provide input to the engineering effort. Also, several theoretical problems are presented that can result in erroneous conclusions and recommendations when certain analysis procedures are used.

11950 Coupled fluid-structure analysis for LWRs in the Federal Republic of Germany. Schlechtendahl, E.G. (Karlsruhe Nuclear Research Center, Germany). *Nucl. Saf.;* **20**: No. 5, 551-563(Sep 1979).

The development of large commercial light-water reactors for electric-power generation in the Federal Republic of Germany is accompanied by a broad program for investigation of the safety aspects of nuclear plants. Considerable effort is devoted to the analysis of transient loads on critical reactor components during abnormal conditions and the response of the components to such loads. This review concentrates on those situations and components where the interaction of fluid and structures must be taken into account in a best-estimate analysis. In these cases an uncoupled analysis would produce unrealistic - though generally conservative - results. The work of several organizations is closely coordinated, both with respect to code development and with respect to code assessment using results from large-scale experiments.

11951 New approach to the problems of electrical interference in instrumentation and control systems. Wilson, I. (United Kingdom Atomic Energy Authority, Winfrith, England). *Nucl. Saf.;* **20**: No. 5, 564-578(Sep 1979).

In the context of nuclear reactor control and safety, electrical interference can be potentially detrimental, sometimes in subtle ways. The most prolific disturbances are generated by switching mains-powered equipment, the local ground structure constituting a

major coupling path via which high-frequency transients can affect electronic systems. When design considerations are outlined, the advantages of using improved screened components, such as super-screened cables, virtually to eliminate interference problems become clear. Procedures for measuring the interference immunity of equipment and of installed systems in situ have been developed. They provide powerful diagnostic, quality control, and commissioning aids. Several case histories are presented to illustrate how the essential principles have been applied successfully in practice and to demonstrate that electrical interference need no longer be a problem.

11952 Kahl relay common-mode failure. Hagen, E.W. (Oak Ridge National Lab., TN). *Nucl. Saf.;* **20**: No. 5, 579-581(Sep 1979).

The failure of the Kahl relays is the only generally acknowledged common-mode failure (CMF) to have occurred in any commercially operated light-water reactor that disabled or compromised the automatic reactor protection system. The incident occurred on July 29, 1965, at the Kahl (VAK) reactor, a 15-MW(e) boiling-water reactor located and operated at Kahl-am-Main in the Federal Republic of Germany.

11953 Preliminary dose and health impact of the accident at the Three Mile Island Nuclear Station. *Nucl. Saf.;* **20**: No. 5, 591-594(Sep 1979).

The Ad Hoc Population Dose Assessment Group is composed of members of the Nuclear Regulatory Commission, the Department of Health, Education, and Welfare, and the Environmental Protection Agency. This group has examined the available data for the period following the accident and has concluded that the off-site collective dose associated with the radioactive material represents minimal risks of additional health effects to the off-site population, e.g., an increase of 1 cancer death over the 325,000 which would otherwise be expected. Furthermore, the collective dose will not be significantly increased by extending the period past April 7.

11954 Developments pertaining to the Three Mile Island accident. Cottrell, W.B. *Nucl. Saf.;* **20**: No. 5, 613-623(Sep 1979).

Some of the developments since August 1979 pertaining to the accident are of general interest and are summarized. No attempt is made to present a comprehensive review of the accident nor to evaluate the material that has become available. The article merely calls attention to the available information.

11955 Selected safety-related events reported in January and February 1979. Casto, W.R. (comp.). *Nucl. Saf.;* **20**: No. 5, 623-624(Sep 1979).

Of the incidents reported during March and April 1979, two are reviewed because of their uniqueness and general interest: (1) feedwater valving problems at Oconee 1 and (2) a loss of coolant inventory at Oyster Creek.

11956 Events resulting in reactor shutdown and their causes. Scott, R.L.; Gallaher, R.B. (comps.). *Nucl. Saf.;* **20**: No. 5, 625-626(Sep 1979).

The licensee event reports that were received at the Nuclear Safety Information Center from May 2 to June 29, 1979, were reviewed, and those events which involved a reactor shutdown are listed.

11957 U.S. National small-angle neutron scattering facility. Hendricks, R.W.; Koehler, W.C. (Oak Ridge National Lab., TN (USA)). *Acta Crystallogr., Sect. A;* **34**: No. , 346(1 Aug 1978).

From 11. international congress of the International Union of Crystallography; Warsaw, Poland (3 - 12 Aug 1978).

ACCIDENT LIABILITY

REFER ALSO TO CITATION(S) 12008

ENERGY STORAGE

REFER ALSO TO CITATION(S) 11839, 12207

11958 (DOE/EDP—0040) **Environmental Development Plan Energy Storage Systems.** (Department of Energy, Washington, DC (USA)). Sep 1979. 80p. Dep. NTIS, PC A05/MF A01.

Environmental Development Plans (EDPs) are prepared by the Department of Energy to help fulfill the Department's responsibility for the development of environmentally acceptable energy technologies. The EDP provides a common basis for planning, managing, and reviewing all environmental aspects of the energy programs under DOE's jurisdiction. The EDP is timed to precede key technology program decisions as the technology moves from the exploratory development stage to an engineering development or technology demonstration phase. To ensure that environmental, health, and safety (EH and S) considerations will be addressed adequately in the technology decision-maing process, the EDP: (1) identifies and evaluates EH and S concerns; (2) defines EH and S research and related assessments to examine or resolve the concerns; (3) provides a coordinated schedule with the technology program for required EH and S research and development; and (4) indicates the timing for Environmental Assessments, Environmental Impact Statements, Environmental Readiness Documents, and Safety Analysis Reports. The initial EDP for Energy Storage Systems (DOE/EDP-0015) was published in March 1978. This EDP provides a substantial updating of the 1978 document. The EDP is being distributed so that everyone having interests and responsibilities with respect to Energy Storage Systems may have the opportunity to review and provide suggested changes for future updates.

MAGNETIC

11959 30-MJ superconducting magnetic energy storage (SMES) unit for stabilizing an electric transmission system. Rogers, J.D.; Boenig; Bronson, J.C.; Colyer, D.B.; Hassenzahl, W.V.; Turner, R.D.; Schermer, R.I. (Univ of Calif, Los Alamos Sci Lab, NM). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 820-823(Jan 1979).

Electric power systems that have major loads and generation centers separated by large distances may experience low-frequency power oscillations. This type of oscillation has occurred on the Pacific AC Intertie that connects southern California and the Pacific Northwest. A separate, almost parallel, dc-transmission line also connects these areas. The Bonneville Power Administration, which operates this transmission system, has overcome the instability by controlling the power transmitted on the dc-transmission line. A 30-Mj (8.4-kwh) superconducting magnetic energy storage unit with a 10 Mw converter could also provide damping for this instability. The conceptual design of the 30-Mj coil and the cryogenic and electrical components of the system are described. The system is to operate at a maximum current of 5 ka and will modulate the ac intertie at 0.35 Hz. Discharge will be controlled to retain a minimum stored energy of 20 mj to limit cyclic strains in the coil and ac losses in the conductor. The conductor will be made of multistrand-copper and copper-matrix, multifilament NbTi superconducting wires on a stainless steel mandrel. 13 refs.

COMPRESSED GAS

REFER ALSO TO CITATION(S) 11972

11960 (EPRI-EM—1218) **Conceptual design of thermal energy storage systems for near-term electric utility applications.** Hall, E.W.; Hausz, W.; Anand, R.; LaMarche, N.; Oplinger, J.; Katzer, M. (General Electric Co., Schenectady, NY (USA)). Nov 1979. Contract EC-77-A-31-1034. 524p. Dep. NTIS, PC A22/MF A01.

The objective of the study was to identify potential concepts, select the most promising ones for conceptual design and make detailed evaluations of their economic feasibility and cost-benefits. Over forty concepts were examined for storage media, forms of containment, and cycle configurations for conversion to electricity. An extensive analysis and screening process resulted in selecting two coal-fired and two nuclear plants for detailed conceptual design. The coal plants utilized peaking turbines and the nuclear plants varied the feedwater extraction to change power output. It was shown that the performance and costs of even the best of these systems could not compete in near-term utility applications with cycling coal plants and typical gas turbines available for peaking power. Lower electricity costs, greater flexibility of operation, and other benefits can be provided by cycling coal plants for greater than 1500 hours of peaking or by gas turbines for less than 1500 hours if oil is available and its cost does not increase significantly.

11961 (PNL-SA—7669) **Compressed air energy storage technology program in the United States.** Loscutoff, W.V. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1979. Contract EY-76-C-06-1830. 8p. (CONF-790515—6). Dep. NTIS, PC A02/MF A01.

From International assembly on energy storage; Dubrovnik, Yugoslavia (27 May 1979).

The development of compressed air energy storage (CAES) technology is a recognized objective of the United States Department of Energy. The specific objectives are to develop the technology to a level that will permit early commercialization of the concept and to develop advanced CAES systems that will not require any petroleum fuels for operation. The paper summarizes the CAES technology research and development program sponsored by the United States Department of Energy and provides a brief set of recommendations on the developments required for the commercialization of the concept.

PUMPED HYDRO

REFER ALSO TO CITATION(S) 11972

11962 (CONF-791204—11) **Assessment of high-head turbomachinery for underground pumped hydroelectric storage plants.** Tam, S.W.; Frigo, A.A.; Blomquist, C.A. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 18p. Dep. NTIS, PC A02/MF A01.

From 2. Miami international conference on alternative energy sources; Miami Beach, FL, USA (10 Dec 1979).

Underground Pumped Hydroelectric Storage (UPHS) plant costs for plants equipped with advanced reversible pumped turbines have been considered. Equipment used includes single- and two-stage reversible pump turbines for operating heads from 500 to 1500 m. The effects of machinery costs, operating heads, plant configurations and sizes have been taken into account. The results indicate that the use of advanced machinery seems to push the minimum UPHS plant cost to heads greater than 1500 m. The employment of advanced, reversible pump turbines seems to be economically attractive. It is shown that pump-turbine efficiencies and the so-called charge/discharge ratio are very important design parameters for UPHS applications and the interactive effects of these parameters have been analyzed. The results show that under certain conditions a pump-turbine option with a higher charge/discharge ratio at the expense of somewhat lower operating efficiency can be desirable. Careful integration of pump-turbine performance characteristics with the overall system consideration (i.e., UPHS plant design and utility grid requirement) bears significantly on the direct cost savings due to the differing capital costs of the various machines. More importantly, such considerations have a significant impact on the storage cost, the most important element in UPHS plant cost considerations.

11963 (SAND—79-7096) **Investigation of the technical and economic feasibility of using pumped well-water energy storage systems. Final report.** (BDM Corp., Albuquerque, NM (USA)). Dec 1979. Contract EY-76-C-04-0789. 92p. Dep. NTIS, PC A05/MF A01.

The report presents a summary of the work completed on the three technical tasks of the project. The first task included a conceptual/preliminary system design, a selection of potential geographic locations in New Mexico for this system, and a study of relating institutional issues. The second task included a design of the baseline energy storage system with the identification of major components (off the shelf) and their associated performance characteristics, preliminary cost estimates for major system components, overall system performance estimates, and a proposed site location within New Mexico. The third task area included an estimate of the capital cost for the storage system (e.g., costs of major components and processes, O and M costs) and an estimate of the potential annual fossil fuel savings.

CAPACITOR BANKS

REFER ALSO TO CITATION(S) 12046

11964 (AD-A—069199) **Digital simulation and parameter estimation techniques for the e-line pulse-forming network. Master's thesis.** Vannoy, L.W. (Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering). Mar 1979. 115p. Availability: Microfiche copies only.

A line-type, voltage-fed, pulse-forming network, called the E-Line, is studied. The energy to be delivered to the load is stored in a source capacitor at the front of the network. Storing all the energy in the source capacitor leads to a more reliable and lightweight system than is achievable by a conventional network where all the capacitors store energy. The network is to deliver 100-200 rectangular pulses per second to the load where each pulse is 20-30 microseconds in duration and has a pulse height of 30,000 volts. A computer program is developed which models the discharge of the network and is used to analyze the output pulse shape for different inductor and capacitor values within the network. Another computer program is developed which estimates the inductor and capacitor values needed for the network to give a close approximation to the desired rectangular pulse. The simulation program models the discharge of the actual network very well. The estimation program as applied in this thesis does a poor job of predicting the inductor and capacitor values needed. The desired rectangular pulse is not achieved. Recommendations are included which may improve the simulation program, estimation program, and the actual pulse shape.

FLYWHEELS

REFER ALSO TO CITATION(S) 12001, 12119

11965 (COO—4094-70) **System design, test results, and economic analysis of a flywheel energy storage and conversion system for photovoltaic applications.** Millner, A.R.; Dinwoodie, T. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.; Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). 1980. Contract EY-76-C-02-4094. 7p. (CONF-800106—18). Dep. NTIS, PC A02/MF A01.

From 14. photovoltaics specialists conference; San Diego, CA, USA (7 Jan 1980).

MIT Lincoln Laboratory is developing a flywheel interface and storage system for use with photovoltaic power sources. Test data on the performance of components built to investigate the feasibility of such a system, and the results of economic studies of the system showing user-worth analysis and manufacturing-cost estimates, are presented. The system has magnetic bearings, a maximum-power-point tracker, DC input, and cycloconverter output from an ironless-armature motor-generator.

11966 (PB—293857) **Wayside energy storage study. Volume I. Summary. Final report May 1977-June 1978.** Lawson, L.J.; Cook, L.M. (AiResearch Mfg. Co., Torrance, CA (USA)). Feb 1979. Contract DOT-TSC-1349. 79p. NTIS PC A05/MF A01.

Volume I summarizes an in-depth application study which was conducted to determine the practicality and viability of using large wayside flywheels to recuperate braking energy from freight trains on long downgrades. The study examined the route structures of nine U.S. railroads and identified various wayside energy storage system (WESS) configurations. The optimum means of transferring energy from the train to the wayside was by means of a high-voltage ac catenary from either regenerative electric locomotives or modified dual-mode (diesel-electric/electric) locomotives. The application of WESS was then analyzed for four specific routes of typical U.S. railroads. These routes and the annual returns on investment (ROI's) resulting from WESS deployment on existing railroads were as follows: Atchinson, Topeka, and Santa Fe (Los Angeles to Belen), 27.1 percent; Black Mesa and Lake Powell, 17.3 percent; Conrail (Pittsburgh to Harrisburg), 22.0 percent; Union Pacific (Los Angeles to Salt Lake City) 20.2 percent.

11967 (PB—293858) **Wayside energy storage study. Volume II. Detailed description and analysis. Final report May 1977-June 1978.** Lawson, L.J.; Cook, L.M. (AiResearch Mfg. Co., Torrance, CA (USA)). Feb 1979. Contract DOT-TSC-1349. 291p. NTIS PC A13/MF A01.

Volume II summarizes an in-depth application study which was conducted to determine the practicality and viability of using large wayside flywheels to recuperate braking energy from freight trains on long downgrades. The study examined the route structures of nine U.S. railroads and identified various wayside energy storage system (WESS) configurations. The optimum means of transferring energy from the train to the wayside was by means of a high-voltage ac catenary from either regenerative electric locomotives or modified dual-mode (diesel-electric/electric) locomotives.

11968 (PB—293860) **Wayside energy storage study. Volume IV. Dual-mode locomotive: preliminary design study. Final report June 1978-October 1978.** Lawson, L.J.; Cook, L.M. (AiResearch Mfg. Co., Torrance, CA (USA)). Feb 1979. Contract DOT-TSC-1349. 54p. NTIS PC A04/MF A01.

A preliminary design study was conducted to confirm the technical viability and economic attractiveness of the dual-mode locomotive concept based on the most common U.S. road locomotive, the SD40-2. The study examined the existing characteristics of the base locomotive and ensured that operation in the diesel mode would not be compromised by a locomotive which has a pantograph, transformer, converter, and choke added to permit operation from a 50 kV catenary. The study concluded that the concept is technically viable (although some equipment is only available overseas) and is economically attractive, the top line modification cost being $217,500.

11969 (UCRL—15154) **Laminated composite disc flywheel development. Second interim report, January 1979-June 30, 1979.** Nimmer, R.P.; Torossian, K.A.; Hickey, J.S. (General Electric Co., Schenectady, NY (USA). Materials and Processes Lab.). Jul 1979. Contract W-7405-ENG-48. 75p. Dep. NTIS, PC A04/MF A01.

The objective of the current program is to demonstrate a prototype practical flywheel design which has high energy storage capacity and also has the potential of being integrated into a hybrid flywheel/electric vehicle system. Quantitative program goals have been set as a 45 to 55 Wh/kg (20 to 25 Wh/lb) working energy density for wheels with a total storage capacity in the 1 to 2 kWh range. The goal for energy density at failure has been set at 88 Wh/kg (40 Wh/lb). Although even higher energy densities at failure are theoretically possible, our goals are tempered by the objective of demonstrating practical flywheel configurations which meet constraints of cost, fabricability, and system integration.

THERMAL

REFER ALSO TO CITATION(S) 11633, 11699

11970 (DOE/NASA/1034—80/7) **Engineering evaluation of a sodium hydroxide thermal energy storage module.** Perdue, D.G.; Gordon, L.H. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Feb 1980. Contract EC-77-A-31-1034. 23p. (NASA-TM—81417). Dep. NTIS, PC A02/MF A01.

As part of the Department of Energy's Thermal Energy Storage Program, the NASA Lewis Research Center performed an engineering evaluation of storage prototypes to assess the development status of latent heat storage media. This report describes the testing and the evaluation of a prototype sodium hydroxide module developed by Comstock and Wescott, Inc. The module stored off-peak electrical energy as heat for later conversion to domestic hot water needs.

11971 (LBL—10194) **Multiple well variable rate well test analysis of data from the Auburn University Thermal Energy Storage Program.** Doughty, C.; McEdwards, D.; Tsang, C.F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 30p. Dep. NTIS, PC A03/MF A01.

The computer program ANALYZE is used to determine reservoir parameters and the unique location of a hydrologic boundary for the aquifer used by Auburn University in a series of aquifer thermal energy storage field experiments. ANALYZE can deal with several observation wells and account for variable flow rates in multiple production wells. Two injection tests and one production test were analyzed. All yielded similar values of reservoir parameters and barrier location.

11972 (PB—290835) **Inventory of underground energy storage sites in California. Final staff report.** Jones, M.A. (California Energy Commission, Sacramento (USA)). Oct 1978. 99p. NTIS, PC A05/MF A01.

Compressed air and pumped hydropower, heat from solar thermal systems, and natural gas and petroleum products can be stored underground. Gas fields, oil fields, saline aquifers, hard rock sites, caves and abandoned mines with minimum storage volumes of five million cubic feet and maximum depths of 3,500 feet are identified as potential energy storage sites. Data collected on compressed air energy storage sites in California is included and supplemented by information on California oil and gas fields. The information given for each site includes: the site name, location, depth to storage medium, volume, rock type, rock thickness, permeability, porosity, pressure containment capacity, and distance to transmission facilities, pipelines and geologic hazards.

BATTERIES

REFER ALSO TO CITATION(S) 12225

11973 (NTIS/PS—79/0780) **Lead batteries (citations from the NTIS data base). Report for 1964-Jul 1979.** Cavagnaro, D. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 169p. NTIS PCN01/MF N01.

The design, development, components, fabrication, chemistry, and testing of lead batteries are cited in this compilation of Federally-funded research. Specific applications for spacecraft, consumer products, and electric vehicles are covered. Studies on lead recovery from battery scrap are covered. Several abstracts on lead toxicity in industrial plants are also cited. (This updated bibliography contains 163 abstracts, 39 of which are new entries to the previous edition.)

11974 (NTIS/PS—79/0781) **Lead batteries. Volume 1. 1970-1976 (citations from the Engineering Index data base). Report for 1970-1976.** Cavagnaro, D. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 213p. NTIS PCN01/MF N01.

Reports from worldwide research are cited, covering lead battery components, charging, corrosion, and testing. The majority of studies cover batteries used in electric vehicles. Citations on lead recovery from battery scrap and air pollution at battery factories are also included. (This updated bibliography contains 207 abstracts, none of which are new entries to the previous edition.)

11975 (NTIS/PS—79/0782) **Lead batteries. Volume 2. 1977-July, 1979 (citations from the Engineering Index data base). Report for 1977-jul 79.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 121p. NTIS PCN01/MF N01.

Worldwide research on lead battery components, charging, corrosion, and testing is cited. The majority of studies concern battery use in electric vehicles. Studies on lead recovery from battery scrap and air pollution at battery factories are also included. (This updated bibliography contains 115 abstracts, 59 of which are new entries to the previous edition.)

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 11602, 11980, 11984, 12154

11976 (PB—290934) **Energy storage with ambient temperature rechargeable lithium batteries. Final report, 1 April 1975-31 December 1977.** Brummer, S.B.; Dampier, F.W.; Koch, V.R.; Rauh, R.D.; Reise, T.F. (EIC, Inc., Newton, MA (USA)). Jan 1978. Contract NSF-AER75-03779. 284p. NTIS, PC A13/MF A01.

An ambient temperature rechargeable lithium battery with characteristics suitable for load-levelling and electric vehicle applications was developed. The battery was to use an organic electrolyte and a dissolved depolarizer. Studies were made of transition metal depolarizers. Their major problem was excessive self-discharge. The depolarizer of choice is lithium/polysulfide, which is very soluble and discharges and recharges readily. Its self-discharge reaction with lithium is slow and leads to soluble lower polysulfides. The initial problems of this system which operates a little above room temperature (approximately 50 degrees centigrade) were moderate rate capability and modest recharging of the lithium electrode. Effort was directed at improving the recharging of the lithium electrode and its performance was greatly improved. Improvements in the cycling performance were in large part due to the development and refinement of techniques for the preparation of high-purity electrolyte. It was found that a procedure in which the solvent is passed through a column of neutral alumina, the electrolyte prepared and pre-electrolyzed in a specific way, then passed through a second column of alumina gives the best cycling results. Promising lithium cycling results were achieved using an aluminum alloying substrate and a one molar lithium arsenic fluoride/tetrahydrofuran electrolyte.

11977 **Safe high energy density battery.** Goodson, F.R.; Shipman, W.H.; McCartney, J.F. US Patent 4,145,484. 20 Mar 1979. Filed date 23 Jan 1978. 4p.

This patent covers a safe high energy density battery which includes a lithium anode, a catholyte of bromine, and an electrolyte of tetrabutylammonium bromine.

11978 **Device for production of electric current in an electrochemical manner.** Freistaedter, O. (to Deutsches Patentamt, Muenchen (Germany, F.R.)). German(FRG) Patent 2,530,326/C/. 1 Feb 1979. 6p. (In German).

Zinc anode material, electrolyte-containing separator and activated carbon for the reduction of air-oxygen are emplaced on separate foil bands which themselves are wound on three separate rolls. The three bands are unwound at the same rate and pressed together for a certain length and time forming the actual primary element. The unwinding rate is directly proportional to the desired current strength. The foilbands can also be constructed so that the total system can act as a secondary battery.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 11984

11979 (AD-A—068216) **Nickel/cadmium aircraft batteries: practical resistance measurements. Technical note.** Feldmen, K.; Verville, G.; Haines, R.L. (Defence Research Establishment, Ottawa, Ontario (Canada)). Feb 1979. 28p. NTIS, PC A03/MF A01.

No abstract available.

11980 (N—79-16374) **Fabrication and testing of silver-hydrogen cells.** Klein, M.G. (Energy Research Corp., Bethel, CT (USA)). Nov 1978. Contract NAS3-19780. 48p. NTIS, PC A03/MF A01.

The development and life testing of single electrode and multielectrode stacks to optimize the individual components and characterize the performance of a silver hydrogen battery system are described. A NASA-developed inorganic separator material was used as the main separator within the cells. Single electrode test cells were cycled at 75% of nominal capacity out through approximately 1,000 cycles in a number of cases where deterioration in performance was observed. This deterioration appears to be a decay in usable capacity of the silver electrode; but the exact mechanism is still unidentified. Twenty ampere-hour boilerplate test cells consisting of a stack of ten silver electrodes and twenty hydrogen electrodes were cycled also at 75% depth of discharge. The oldest stack achieved 522 stable cycles to the end of the program. Weight analysis of light-weight cells showed that 50 ampere-hour cells with improved components could be capable of as much as 40 watt hours per pound.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 11568, 11600, 12067

11981 (AD-A—069846) **Basic studies of the lithium secondary electrode. Technical report 1 Feb 1978-31 Jan 1979.** Brummer, S.B.; Koch, V.R.; Goldman, J.L.; Mank, R.M.; Mattos, C.J. (EIC, Inc., Newton, MA (USA)). Apr 1979. Contract N00014-77-C-0155. 27p. NTIS, PC A03/MF A01.

Rechargeable high energy density Li batteries require an efficient Li electrode. Earlier work with propylene carbonate (PC), methyl acetate (MA), and tetrahydrofuran (THF)-based electrolytes yielded poor Li electrode cycling efficiencies due to the electrolyte reduction by Li. We find 2-methyltetrahydrofuran (2-Me-THF)/LiAsF6 media to be remarkably stable toward Li; this stability results in cycling efficiencies which approach 98%. The ability of 2-Me-THF in particular, and alpha-methylated THFs in general, to resist reduction by Li is thought to be based on the position of its lowest unfilled molecular orbital (LUMO) relative to that of THF.

11982 (N—79-16375) **Fabrication and testing of silver-hydrogen cells.** Debicarri, D.J.; Charkey, A. (Energy Research Corp., Bethel, CT (USA)). Dec 1978. Contract NAS3-20805. 26p. NTIS, PC A03/MF A01.

Silver electrodes containing various additives were fabricated and tested in single electrode cells in order to improve the electrochemical utilization of sintered silver cathodes in Ag-H_2 aerospace batteries. A standard stack arrangement was used which featured a NASA-developed organic-inorganic separator. All cells were cycled in a regime designed to remove 75% of the cells nominal capacity based on 3.3 gms/Ah Ag utilization. In cases where performance degradation was observed, the main feature mode appeared to be corrosion of either the expanded silver current collector or the connection between the silver electrode and the electrode tab. Promising silver electrodes from single electrode studies were used in the construction of 35 Ah Ag-H_2 cells. Two such cells were constructed and installed in heavy walled pressure vessels for testing. Based on the data obtained from all cells tested during the program, four lightweight 35 Ah cells were fabricated. During acceptance testing these cells yielded an average gravimetric energy density of 30 Wh/lb.

11983 **Positive electrode for air/zinc batteries.** Sauer, H.; Kloss, W. (to Varta Batterie A.G., Hannover (Germany, F.R.); Deutsches Patentamt, Muenchen (Germany, F.R.)). German(FRG) Patent 2,626,975/C/. 26 Apr 1979. 4p. (In German).

The invention concerns a positive electrode for air/zinc batteries in which the depolarizer mass with an intermediate layer of conductor foil and metal foil as conductor, both perforated, is deposited on a plastic carrier which is also perforated. The assembly of the single components of the positive electrode is simplified and the metal foil and conductor foil are fixed corrosion-protected on the plastic carrier if as according to the invention, the air holes of the plastic carrier have hollow rivet-like shapes with pertruding rims through which the foils are fixed with central holes lying on top of one another on the plastic carrier.

11984 **Chalcogenide battery.** Eisenberg, M. (to Electrochimica Corp.). US Patent 4,136,233. 23 Jan 1979. Filed date 25 Jan 1978. 4p.

A battery comprises an anode having an anode-active metal selected from the group consisting of Group Ia metals, Group Ib metals, Group IIa metals, Group IIb metals, Group IIIa metals and mixtures thereof. The cathode has a cathode-active material consisting essentially of a chalco-spinel of the formula M/sub a/N/sub b/Z/sub x/, wherein M is a divalent ion selected from the group of metals consisting of copper, zinc, cadmium, iron, cobalt, nickel, manganese, molybdenum, vanadium, and chromium, N is a trivalent ion selected from the group of metals consisting of iron, cobalt, nickel, and metals of Group IVb, Vb, and VIIb of the periodic system, Z is an element selected from the group consisting of sulfur, selenium, and tellurium, a is a numerical value between 0.90 and 1.10, b is a numerical value between 1.80 and 2.20, and x is a numerical value between 3.80 and 4.20. 19 claims.

APPLICATIONS

REFER ALSO TO CITATION(S) 11627

ENERGY MANAGEMENT AND POLICY

REFER ALSO TO CITATION(S) 12069, 12077

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 12050, 12098, 12112, 12869

11985 (BNL—50940) **Demand elasticity representation: methodology and calibration.** Kydes, A.S. (Brookhaven National Lab., Upton, NY (USA)). Jul 1979. Contract EY-76-C-02-0016. 51p. Dep. NTIS, PC A04/MF A01.

This paper describes the methodology incorporated within a version of the Brookhaven Energy System Optimization Model (BESOM) to yield first-order approximations of the response of a national energy system, in economic equilibrium, to changes in prices, quantity of fuel available, and changes in the technological structure of the energy-conversion devices - including efficiency changes. The methodology is not intended as a substitute for the comprehensive energy-economic analysis derivable from the BNL Dale Jorgenson Associates suite of models. It is intended as an inexpensive tool for performing firsr-order sensitivity of energy systems around an established energy-economic equilibrium point.

11986 (DOE/CS/20158—T1) **Development of a risk analysis model. Appendix C. Risk analysis methodology. Final report.** (Dynatrend, Inc., Arlington, VA (USA); ECON, Inc., Princeton, NJ (USA)). Oct 1979. Contract AC03-77CS20158. 34p. Dep. NTIS, PC A03/MF A01.

Three case studies were included in the process of the contract effort. This appendix provides general information concerning the model used in the three case studies, its input data requirements, and its output reports. This appendix should be used in conjunction with each of the separately bound case studies: Appendix D, Gas Fired Heat Pump Case Study; Appendix E, 1000 Ton Per Day Anaerobic Digestion Plant Case Study; and Appendix F, District Heating and Cooling System Case Study.

11987 (DOE/CS/20158—T2) **Development of a risk analysis model. Appendix F. District heating and cooling system case study. Final report.** (Dynatrend, Inc., Arlington, VA (USA); ECON, Inc., Princeton, NJ (USA)). Oct 1979. Contract AC03-77CS20158. 111p. Dep. NTIS, PC A06/MF A01.

The risk analysis reported in this appendix was concerned with a business venture in the area of district energy systems using thermal energy cogenerated at existing electric power plants. After an introductory section, Section 2, Institutional Issues, discusses investment decisions and regulatory constraints and issues; Section 3 reviews public utility company objectives and investment analysis approach; Section 4 reviews the case study of district heating and cooling systems (DHCS) in Washington, DC; Section 5 results of the Minneapolis/St. Paul case DHCS study; Section 6 summarizes the desired risk-analysis methodology for evaluating regulated utility investment decisions; and Section 7 presents overall conclusions. (MCW)

11988 (DOE/EIA—0186) **Multiyear program plan for the Office of Applied Analysis.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 4 Jun 1979. 208p. Dep. NTIS, PC A10/MF A01.

The Office of Applied Analysis of the DOE Energy Information Administration is charged with the responsibility of forecasting and analyzing the effects and impacts of energy-related events and policies. The Applied Analysis Program Plan has two objectives. First, it is intended to serve as a management tool for planning the direction of program objectives and projects, tracking estimated timeframes, and managing resources. Second, it lays out in a comprehensive fashion the Office's overall mission, ongoing activities, measurable objectives, and resource allocation over the next few years as currently planned. Applied Analysis is divided into 7 program areas with relevant subprograms associated with each program. Major directions that are planned are first discussed briefly, followed by details on the 7 programs, namely: Analysis Management; Analysis Oversight and Access; Energy Source Analysis; Energy Use Analysis; Energy Market Analysis; Energy Economy Analysis; and Energy Industry Analysis. Finally, six appendices expand on material appearing in the program plans, list relevant legislative citations, and summarize broad operating principles and policies. (MCW)

11989 (DOE/EIA/6345—T1) **Direct regional energy/economic modeling (DREEM) design.** Hall, P.D.; Pleatsikas, C.J. (Urban Systems Research and Engineering, Inc., Cambridge, MA (USA)). Oct 1979. Contract EI-78-C-01-6345. 146p. Dep. NTIS, PC A07/MF A01.

This report summarizes an investigation into the use of regional and multiregional economic models for estimating the indirect and induced impacts of Federally-mandated energy policies. It includes an examination of alternative types of energy policies that can impact regional economies and the available analytical frameworks for measuring the magnitudes and spatial extents of these impacts. One such analytical system, the National Regional Impact Evaluation System (NRIES), currently operational in the Bureau of Economic Analysis (BEA), is chosen for more detailed investigation. The report summarizes the models capabilities for addressing various energy policy issues and then demonstrates the applicability of the model in specified contexts by developing appropriate input data for three scenarios. These scenarios concern the multi-state impacts of

alternative coal-mining-development decisions, multi-regional impacts of macroeconomic change, and the comprehensive effects of an alternative national energy supply trajectory. On the basis of this experience, the capabilities of NRIES for analyzing energy-policy issues are summarized in a concluding chapter.

11990 (EPRI-EA—1231) **Correction of end effects in energy-planning models. Final report.** Grinold, R.C. (California Univ., Berkeley (USA)). Nov 1979. 55p. Dep. NTIS, PC A04/MF A01.

End effects are distortions in the outputs of planning models that result from planning over a fixed time span rather than the indefinite future. The report presents and analyzes several ways to mitigate end effects. The qualitative conclusions are tested and confirmed using an energy-planning model. The reduction of end effects allows a model builder to shorten the length of the planning period. This, in turn, can result in considerable savings in computational costs or can allow the model builder to enrich other aspects of the model.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 11229, 11367, 11576, 11577, 11985, 11989, 12002, 12016, 12017, 12018, 12019, 12030, 12049, 12052, 12079, 12089, 12546, 12592

11991 (DOE/EIA—0043/7(78)) **Energy data report.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Nov 1978. 19p. Dep. NTIS, PC A02/MF A01.

Preliminary statistics for July from the Energy Information Administration's (EIA) revised survey of retail gasoline stations indicate that, nationally, leaded regular gasoline at full serve pumps (Table 1) sold for an average of 64.6 cents per gallon, which is 1.2 cents above the price in June. The price for unleaded regular gasoline at full serve pumps increased 1.0 cent to 68.8 cents per gallon, which was 4.2 cents above the price for leaded regular gasoline at fuell serve pumps. Self-serve leaded and unleaded regular gasoline prices were 60.6 and 65.6 cents per gallon, respectively.

11992 (DOE/EIA—0184/27) **Estimates of energy non-resource costs: energy taxes and subsidies. Analysis report.** (Department of Energy, Washington, DC (USA)). Nov 1979. 29p. Dep. NTIS, PC A03/MF A01.

This report establishes quantitative estimates of selected taxes and subsidies that impact the costs of producing and consuming different energy sources. The taxes and subsidies selected for discussion are judged to be unrelated to any direct valuation of resources used in the production and distribution process, and further, these taxes and subsidies are not applied uniformly to each fuel type. Such lack of uniformity in treatment prevents comparisons of energy costs on a consistent basis. This report presents estimates of each relevant tax ans subsidy program and describes the methodology used to calculate specific impacts on the marginal costs for each fuel type. Results are reported for 1979, 1985, 1990, and 1995 at the national level. The esimates of tax and subsidy impacts can be used in conjunction with the Analysis Reports, Projecting Marginal Energy Costs Using the Mid-Term Energy Forecasting System, and Marginal Costs of Energy in 1979: Estimates by Economic Sector and Fuel Type, to isolate the direct resource costs of alternative energy sources.

11993 (DOE/PE—0017) **Renewable energy development: local issues and capabilities.** (Department of Energy, Washington, DC (USA). Office of Policy and Evaluation). Jan 1980. 347p. Dep. NTIS, PC A15/MF A01.

More than 300 organizations responded to a DOE request seeking information from organizations interested in development of renewable energy sources and specifically, those organizations with the capability to perform innovative planning, research, and analysis for the development of renewable energy resources at the local, state, and regional level. The first chapter summarizes the broad characteristics of the responses into these areas: research, development, demonstration; socio-economic analysis; information collection and dissemination; technology transfer or assessment; education and training; systems or policy analysis; community development; program planning; architectural design; and technical assistance. Additional chapters are: Respondents' Issues and Concerns; Using the Respondents' Capabilities; and Detailed Capabilities of Respondents. (MCW)

11994 (EMD—79-45) **Are OPEC financial holdings a danger to US banks or the economy.** Staats, E.B. (General Accounting Office, Washington, DC (USA)). 11 Jun 1979. 63p. General Accounting Office, 441 G. St., NW, Washington, DC.

Concern exists that OPEC financial holdings - both US Government securities and deposits in US banks here and abroad - might, either because of their size or the possibility of their rapid liquidation, be a threat to the United States. These holdings do not constitute an immediate danger to US banks or the economy. US financial markets and the structure of the banking system are adequate to absorb the impact of rapid liquidation. Furthermore, the President has sufficient authority to deal with an international financial emergency. But while the rapid disposal of OPEC assets does not pose a significant danger, the implications of a long-term withdrawal of these funds from the United States and US financial institutions could be adverse. Such a withdrawal would not only increase the cost of money to US banks and the Treasury, but could also impede client relationships of US financial institutions. OPEC's real strength and bargaining power lies in its control of a major portion of the world's oil supply, upon which the United States relies for 80% of its oil imports. Manipulating the price or supply of oil or the threat of manipulation is likely to have a greater impact on the US economy and financial markets than OPEC's use of its financial holdings.

11995 (PB—290588) **Outlook for energy and implications for irrigated agriculture. Technical report.** Patton, W.P.; Lacewell, R.D. (Texas A and M Univ., College Station (USA). Water Resources Inst.). Sep 1977. Contracts DI-14-34-0001-7091;DI-14-34-0001-7092. 66p. NTIS, PC A04/MF A01.

Agriculture uses large quantities of energy to pump groundwater for irrigation. This means the cost of energy has important implications for the industry in terms of costs and profitability. Increases in the prices of energy sources such as natural gas, electricity, liquid petroleum gas and diesel can cause economic hardship for irrigators, particularly if those increases are unanticipated. The purpose of this paper is to briefly summarize important trends in the current domestic energy situation that could have significant impacts on the future cost and availability of energy, and to show what the implications of those trends are for irrigated agriculture. The primary focus is on trends in natural gas, since natural gas is the major fuel used for irrigation in the Great Plains states.

11996 (PNL-RAP—36(Vol.3)) **Regional Issue Identification and Assessment (RIIA). Volume III. Institutional barriers to developing power generation facilities in the Pacific Northwest.** Morris, F.A.; Sawyer, C.H.; Maxwell, J.H. (Battelle Human Affairs Research Center, Seattle, WA (USA)). Oct 1979. Contract EY-76-C-06-1830. 99p. Dep. NTIS, PC A05/MF A01.

The Regional Assessments Division in the US Department of Energy (DOE) has undertaken a program to assess the probable consequences of various national energy policies in regions of the United States and to evaluate the constraints on national energy policy imposed by conditions in these regions. The program is referred to as the Regional Issues Identification and Assessment (RIIA) Program. Currently the RIIA Program is evaluating the Trendlong Mid-Mid scenario, a pattern of energy development for 1985 and 1990 derived from the Project Independence Evaluation System (PIES) model. This scenario assumes a medium annual growth rate in both the national demand for and national supply of energy. It has been disaggregated to specify the generating capacity to be supplied by each energy source in each state. Pacific Northwest Laboratory (PNL) has the responsibility for evaluating the scenario for the Federal Region 10, consisting of Alaska, Idaho, Oregon, and Washington. PNL is identifying impacts and constraints associated with realizing the scenario in a variety of categories, including air and water quality impacts, health and safety effects, and socioeconomic impacts. This report summarizes the analysis of one such category: institutional constraints - defined to include legal, organizational, and political barriers to the achievement of the scenario in the Northwest.

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 11123, 11138, 11284, 11367, 11843, 12485, 12486, 12491, 12496, 12538, 12664, 12687

11997 (CONF-791009—12) **Relative risk assessment and projected body burdens: a tool for energy use management.** Gasper, J.R.; Dauzvardis, P.A. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 13p. Dep. NTIS, PC A02/MF A01.

From International conference on energy use management; Los Angeles, CA, USA (22 Oct 1979).

In the area of health assessment of the impacts of tradeoffs between health, economic, social, environmental and energy availability considerations, gaps exist in both methodology and information. This paper describes a method for dealing with human response to hazardous pollutants emitted by energy technologies and presents a sample application of the methodology. (ACR)

11998 (PB—293024) **Environmental actors in energy in the New York area. Working paper.** Aron, J.; Shienbaum, E. (New York Regional Energy Study, NY (USA)). Feb 1975. 39p. NTIS, PC A03/MF A01.

The possible impact of areawide residential location policy on future residential electricity usage in the Tri-State Metropolitan Region centering on New York City is investigated. This paper presents a brief overview of the common features, orientation, and behavior of the prominent environmental interest groups that participate in decision-making in energy in the New York area. The account also summarizes the characteristics of the regulatory process that bias decisions in favor of the utilities and industrial concerns to the disadvantage of the newer environmental participants. Environmental interest groups in the New York area are divided into two broad 'ideal types': 'crisis-activated interest groups', relatively short lived organizations, whose concerns are immediate and limited to specific issues within a geographic area, and 'institutionalized interest groups', relatively stable and permanent associations, whose concern in regional energy issues develops out of a broad comprehensive interest in environmental matters. Findings indicate that 'crisis-activated' groups tend to have specific impacts (primarily negative) with respect to policy decisions. 'Institutionalized groups' tend to have more diffuse effects which may be broader in scope and more far reaching than those of the temporary associations.

11999 (PB—293476) **The coastal zone management act: requirements for the management of energy facilities in the coastal zone. volume i.** (Florida Div. of State Planning, Tallahassee (USA)). 13 Jan 1978. 152p. NTIS, PC A08/MF A01.

A partial listing of topic areas includes: Identification and analysis of existing state and local authorities and management techniques affecting energy facility siting; Identification of energy facilities likely to locate in or which may significantly affect the coastal zone; Authorities and management programs that may be used to manage the siting of an impacts from energy facilities in the coastal zone.

12000 (UCID—18147) **Cost and effectiveness of exercise evacuations to increase radiological emergency preparedness.** Fischer-Colbrie, E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Dec 1979. Contract W-7405-ENG-48. 33p. Dep. NTIS, PC A03/MF A01.

This investigation of the expected cost and effectiveness of exercise evacuations from the vicinity of nuclear power plants led to the following results and conclusions: the estimated total cost per person and day varies from $17.34 to $78.20. The motivation of the public to participate in drill evacuations appears to be very low. In contrast to popular beliefs actual evacuations from disaster areas other than nuclear have been carried out consistently in orderly fashion without drills. Nuclear radiation as an unfamiliar agent of threat is not expected to change this pattern. Exercise evacuations are very costly and virtually no increase in preparedness can be gained through their execution.

NATURAL RESOURCES

REFER ALSO TO CITATION(S) 11833, 12107, 12172

12001 (APL/JHU-EQR—78-1) **Energy programs. Quarterly report, January-March 1978.** (Johns Hopkins Univ., Laurel, MD (USA). Applied Physics Lab.). 1978. Contract EC-77-C-01-5085. 41p. Dep. NTIS, PC A03/MF A01.

The Johns Hopkins University Applied Physics Laboratory is engaged in the development of energy resources, energy utilization concepts, and energy storage methods. This Quarterly Report, summarizing work completed on the various tasks as of 31 March 1978, contains comments on limited tasks, short descriptions of meetings, trips, presentations, and other limited tasks of note performed in connection with major program tasks and articles that describe these program tasks briefly, summarize the progress made to date, and indicate future efforts to be made. The major tasks fall into the following categories: Geothermal Energy Development Planning, which concentrates on the survey of potential geothermal resources and the development of scenarios for possible exploitation and utilization in DOE/DGE Region 5, which includes all the United States east of the Rocky Mountains, excluding Texas and Louisiana; Applications Study of DOE/DGE Region 5, which concerns a study of geothermal energy applications in DOE-selected areas of the Atlantic Coastal Plain; the Low-Head Hydroelectric Program; the Community Annual Storage Energy System (CASES) and the status of a development and demonstration plan for a low-cost flywheel; and multiple-objective modeling of power plant locations.

RESEARCH, DEVELOPMENT, DEMONSTRATION, AND COMMERCIALIZATION

REFER ALSO TO CITATION(S) 12172, 12867, 12868

12002 (DOE/CR—0012) **Budget brief, 1981.** (Department of Energy, Washington, DC (USA)). 1980. 74p. Dep. NTIS, PC A04/MF A01.

The FY DOE budge totals $12.6 billion in budget authority and $11.1 billion in budget outlays. The budget authority being requested consists of $10.3 billion in new authority and a $2.3 billion reappropriation of expiring funds for the Strategic Petroleum Reserve. Areas covered in the Energy budget are: energy conservation; research, development, and applications; regulation and information; direct energy production; strategic energy production; and energy security reserve. Other areas include: general science, defense activities; departmental administration; and legislative proposal - spent fuel. Budget totals are compared for 1980 and 1981. A detailed discussion of the FY 1981 activities to be undertaken to carry out these activities is provided. (MCW)

12003 (PB—293882) **Directory of Montana energy research and development projects.** McLane, N.B. (Montana Energy Office, Helena (USA)). Jan 1978. 407p. NTIS, PC A18/MF A01.

The Montana Energy Office has compiled this Directory to provide a current inventory of all ongoing and recently completed (since 1974) energy-related research projects and programs which pertain to the State of Montana. The Directory is indexed by investigator, organization (both funding agencies and research institutions), and subject (including geographic location). Each project contains the following information: project title (and contract number, if known), investigator(s), funding agency(ies), funding amount, duration, location, description, and publications.

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 11375, 11866, 11867, 11869, 11897, 11917, 12000

12004 (COO—4954-1(Vol.1)) **Energy Economic Data Base (EEDB) Program: Phase I, Volume I. Final report.** (United Engineers and Constructors, Inc., Philadelphia, PA (USA)). Dec 1979. Contract EN-78-C02-4954. 306p. (UE/C-DOE—790930(Vol.1)). Dep. NTIS, PC A14/MF A01.

The Energy Economic Data Base Program, which deals with the development of cost data for nuclear and comparison electric power generating stations, provides periodic updates of technical and cost (capital, fuel, and operating and maintenance) information of significance to DOE. The information allows for evaluation and monitoring of US civilian nuclear power programs and provides a consistent means of evaluation the nuclear option against alternatives. Currently, the EEDB contains 6 nuclear electrical generating plant technical models and 5 comparison coal-fired electrical generating plant technical models. Each of these technical plant models is a complete conceptual design for a single unit, steam electric power generating station located on a standard, hypothetical Middletown site. A description of the site is provided in Appendix A-1 (Volume 2) for nuclear plants, and Appendix A-2 (Volume 2) for coal-fired plants. The EEDB also includes a conceptual design of a coal liquefaction plant for comparison purposes. Volume 1 provides a description of the current Data Base, as of September 30, 1978: gives assumptions and ground rules for the initial-cost update; summarizes the initial cost update, with cost results tabulated; details the initial update of the technical conceptual design, the capital cost, the quantities of commodities and their unit costs, and craft labor man hours and costs for each EEDB program model; and details the fuel-cycle-cost initial update and the operating- and maintenance-cost initial update. Finally, an extensive list of references and a glossary are presented.

12005 (COO—4954-1(Vol.2)) **Energy Economic Data Base (EEDB) Program: Phase I, Volume II. Final report.** (United Engineers and Constructors, Inc., Philadelphia, PA (USA)). Dec 1979. Contract EN-78-C-02-4954. 386p. (UE/C-DOE—790930(Vol.2)). Dep. NTIS, PC A14/MF A01.

This Volume II of Phase I of the Energy Economic Data Base Program contains appendices. Appendix A-1 provides the site and environmental data, derived from Appendix A of Guide for Economic Evaluation of Nuclear Reactor Plant Designs, USAEC Report NUS-531, modified to reflect current requirements. These data form the bases of the criteria used for designing the facility and for evaluating the routine and accidental release of radioactive liquids and gases to the environment. Appendix A-2 provides the site and environmental data as derived from Appendix A of NUS-531, and modified to reflect coal-plant siting, forming the bases of the criteria used for designing the facility and for evaluating the release of liquids and gases to the environment. A description of the topography of the hypothetical city, Middletown, is given. Appendix B provides an overall summary of the conclusions of NUS' work on all NUS tasks in support of the nuclear fuel-cycle work in Phase I. Appendix C-1 introduces the concepts involved and addresses

methods of calculation of fixed charges applicable to investor-owned utilities, as used in the EEDB. Appendix C-2 consists of review and revision of each plant's fuel cycle and operating and maintenance costs in accordance with the EEDB update procedures. In Appendix D, NSSS Capital Costs for a Mature LMFBR Industry, much information is provided on plant description, cost estimate, comparison and discussion, drawings, and equipment list. (MCW)

12006 (PB—292985) **The politics of energy: Case study of Con Edison's nuclear complex at Indian Point, New York. Working paper.** Aron, J.; Seelman, K. (New York Regional Energy Study, NY (USA)). Jul 1974. 66p. NTIS, PC A04/MF A01.

The possible impact of areawide residential location policy on future residential electricity usage in the Tri-State Metropolitan Region centering on New York City is investigated. This paper focuses on the politics of energy in its discussion of Con Edison's Nuclear Complex at Indian Point. The first period of planning (1954 to the late 60's) comprised a relatively closed decision-making process in which a private utility and all levels of government worked closely together toward mutually agreeable ends and was confined to the utility itself. The second period, 1969 to the present, dates from the passage of the National Environmental Policy Act, which required consideration of environmental amenities and values in the formulation of governmental decisions. NEPA and subsequent court interpretations provided useful legal tools to environmental groups which were concerned about the possible detrimental effects of nuclear power plants. As a consequence of statutory and judicial changes, interested citizens and groups gained access to the decision-making process and began to question diverse aspects of the utility's operations. The behavior of the major actors during the two time periods--Con Edison, Atomic Energy Commission, regulatory agencies in New York State, the locality, and private intervenors is analyzed--in terms of roles, goals, and strategies. Major characteristics of the decision-making process during the two time periods are summarized as well as the long term probable impact of the changes detailed on the regulatory process and nuclear power production.

12007 (PNL—2666) **Analysis of print media coverage of nuclear power issues.** Rankin, W.L.; Nealey, S.M.; Montano, D.E. (Battelle Human Affairs Research Center, Seattle, WA (USA)). Apr 1978. Contract EW-78-C-06-1076. 67p. Dep. NTIS, PC A04/MF A01.

224 newspaper articles were sampled from four newspapers, extrapolating to about 2850 nuclear power articles from 1972 to 1976. 124 magazine articles were found in four magazines (Time, Business Week, Scientific American, Environment). The newspapers wee found to run close coverage of nuclear power issues. The articles were mainly (45%) focused on reactors and reactor operation. The articles were judged to be antinuclear more often than pronuclear (only Scientific American discussed benefits more than costs). The same general conclusion was reached for articles on nuclear waste management. (DLC)

12008 **Industry response to Three Mile Island.** *EPRI J.;* **4**: No. 9, 33-36(Nov 1979).

Industry responded to government hearings on the Three Mile Island incident with a self-help approach aimed at increasing the reliability and safety of nuclear power plants. The response was viewed by the Electric Power Research Institute (EPRI) as an affirmation of the utilities' lead responsibility and a commitment to the nuclear option. The utility industry recognizes the role of regulation in safety matters, but accepts a primary responsibility for the three levels of technical design, utility operations, and financial risk-bearing. The utilities have begun an internal review of their activities in order to identify areas for improvement. The Nuclear Safety Analysis Center (NSAC) at EPRI and the Institute of Nuclear Power Operations (INPO) are two independent institutions formed to meet the first two areas of responsibility, while a mutual insurance arrangement will address the third.

12009 **Education and public acceptance of nuclear power plants.** Delcoigne, G. (International Atomic Energy Agency, Vienna, Austria). *Nucl. Saf.;* **20**: No. 6, 655-664(Nov 1979).

The evolution of the so-called nuclear debate from the late 1960s to the present time is reviewed, and the current manifestations of the antinuclear movement in many countries are described. Despite the emergence of pronuclear groups and discussions in many countries, the author concludes that public education is the crux of the problem, and he discusses the role of the International Atomic Energy Agency (IAEA) in the nuclear debate.

12010 **Nuclear energy and German foreign policy.** Kaiser, K. (Deutsche Gesellschaft fuer Auswaertige Politik e.V., Bonn (Germany, F.R.). Forschungsinstitut; Koeln Univ. (Germany, F.R.)). *At. Strom;* **25**: No. 1, 2-5(Jan-Feb 1979). (In German).

From: 6. workshop of the Rheinisch-Westfaelisches Elektrizitaetswerk A.G. 'energy'; Timmendorfer Strand, Germany, F.R. (6 - 9 Nov 1978).

The author shows that the present foreign-policy situation with regard to the nuclear-energy complex is due to political and energy-policy origins. He is further of the opinion that the expansion of nuclear energy - in spite of internal political difficulties - will continue in the long term. Hence breeders and reconditioning will become realities. For German foreign policy this means that it must also carry responsibilities on a global scale in this respect.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 11839, 11961, 12022, 12157

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 11638, 11639, 11640, 11643, 11644

12011 (NTIS/PS—79/0442) **Total energy systems for buildings (citations from the NTIS data base). Report for 1964-March 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). May 1979. 226p. NTIS PCN01/MF N01.

Technology and economics associated with total energy systems are discussed in these Federally-funded research citations. These systems employ a primary source of energy, such as oil, natural gas, or solar heat to provide comprehensive energy requirements in the form of light, heating, cooling, air conditioning, drying, process heat, and power for an industrial plant or for a commercial or public building. Included are schemes for electricity generation, waste heat recovery, and direct power drive of mechanical equipment coupled to a prime mover. The total energy systems concept as applied to residential complexes and communities is discussed in abstracts dealing with Modular Integrated Utility Systems (MIUS) and Integrated Community Energy Systems (ICES). Design, operation, energy conservation potential, and the use of solar energy in total energy systems are covered. (This updated bibliography contains 218 abstracts, 68 of which are new entries to the previous edition.)

12012 (NTIS/PS—79/0443) **Total energy systems for buildings (citations from the Engineering Index data base). Report for 1970-March 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). May 1979. 91p. NTIS PCN01/MF N01.

Technology for total energy systems as applied to residential complexes and industrial plants is discussed in these citations from worldwide research. These systems employ a primary source of energy, such as oil, natural gas, or solar heat to provide comprehensive energy requirements in the form of light, heating, cooling, air conditioning, drying, process heat, and power for an industrial plant or for a commercial or public building. Included are schemes for electricity generation, waste heat recovery, and direct power drive of mechanical equipment coupled to a prime mover. Integrated Community Energy Systems (ICES) and Modular Integrated Utility Systems (MIUS) are covered, including studies on gas turbines for use in MIUS systems, and computerized simulation studies. (This updated bibliography contains 85 abstracts, 20 of which are new entries to the previous edition.)

12013 **Energy cascades in Canada.** Hayden, A.C.; Brown, T.D. Ottawa, Ontario; Minister of Supply and Services Canada (1979). 22p. (CANMET—79-12). Canmet Publication Office, 555 Booth St., Ottawa, Ontario.

Combining energy uses in a cascade can result in significant overall reductions in fuel requirements. The simplest applications for a cascade are in the recovery of waste heat from existing processes using special boilers or turbines. Specific applications of more-complex energy cascades for Canada are discussed. A combined-cycle plant at a chemical refinery in Ontario is world leader in energy efficiency. Total-energy systems for commercial buildings, such as one installed in a school in Western Canada, offer attractive energy and operating cost benefits. A cogeneration plant proposed for the National Capital Region, generating electricity as well as steam for district heating, allows the use of a low-grade fossil fuel (coal), greatly improves energy-transformation efficiency, and also utilizes an effectively renewable resource (municipal garbage). Despite the widespread availability of equipment and technology of energy cascades, the sale of steam and electricity across plant boundaries presents a barrier. More widespread use of cascades will require increased cooperation among industry, electric utilities and the various levels of government if Canada is to realize the high levels of energy efficiency potential available.

CONSERVATION

REFER ALSO TO CITATION(S) 12046, 12050, 12074, 12079, 12085, 12098, 12116, 12135, 12136, 12158, 12543

12014 (CONS—0003-T2) **Illinois Energy Conservation Plan: documentation of DOE-U535-O-A calculations.** (Price Waterhouse and Co., Chicago, IL (USA)). 6 Nov 1979. Contract EW-77-G-45-0023. 124p. Dep. NTIS, PC A06/MF A01.

This report presents data compiled on the estimated energy conservation achieved by programs included in the Illinois Energy Conservation Plan. Summaries are given for the following areas: thermal and lighting standards; state and local procurement standards; carpooling, vanpooling, and public transit; right turn on red; energy data information system; Homeowner's Extension Program; agricultural resource applications; Farm Energy Conservation Program; Commercial Industrial Program; Public Utilities Program; School Energy Management Program; energy management assistance to local government; Administration of State Plan; energy conservation information; energy management for state buildings; solar energy; waste to energy and resource recovery; intergovernmental coordination; community technology assistance.

12015 (EMD—80-11) **Federal Government needs a comprehensive program to curb its energy use.** Staats, E.B. (General Accounting Office, Washington, DC (USA)). 12 Dec 1979. 66p. General Accounting Office, 441 G Street, NW, Washington, DC.

Report to the Congress of the United States by the Comptroller General.

According to this GAO analysis, the Federal Government is not making a sufficient commitment to curbing its energy use. Its program to conserve energy is in disarray. Although the Congress and the President have enacted and issued legislative and executive guidance, a comprehensive and aggressive energy conservation program for the Federal sector has not been developed. The Department of Energy's efforts have been minimal and Federal agencies have resisted Energy's attempts to establish a meaningful program. The Federal Government - the Nation's largest consumer of energy - needs a comprehensive, centrally directed program to curb energy use. This report contains recommendations to the Congress, the President, and the Department of Energy to establish such a program.

12016 (ORAU/IEA—79-19(M)) **Exogenous (nonprice) factors influencing energy/GNP relationships in leading OECD countries.** Allen, E.L.; Edmonds, J.A. (Oak Ridge Associated Universities, Inc., TN (USA). Inst. for Energy Analysis). Dec 1979. Contract EY-76-C-05-0033. 49p. Dep. NTIS, PC A03/MF A01.

This study addresses the effect of major trends other than prices on the energy demand and the energy/gross national product ratio (E/GNP) for six leading countries of the Organization for Economic Cooperation and Development (OECD) - Canada, France, Italy, Japan, the United Kingdom, and West Germany. Demographic, technological, political, and economic factors are analyzed in each country and then compared in a summary, integrated chapter. Demographic trends had the most important influence on energy demand. In each country studied, fertility rates have fallen markedly over the past two decades and now hover around 1.8, well below the population replacement level. This is expected to continue through the remainder of this century. The consequences of low fertility rates include: (1) an increase in the participation of women in the labor force; (2) an increase in the number of female automobile drivers; and (3) a decrease in projected total labor-force growth rates. In addition, the lower rate of household formation implicit in this declining population growth decreases residential energy use relative to GNP. Industry represents the largest energy-consuming sector. Industrial energy use is expected to continue a long-term downward trend relative to GNP, even in the absence of energy price increases.

12017 (ORAU/IEA—79-22(M)) **Federal Republic of Germany: estimates of future energy/GDP relationships.** Williamson, R.B.; Allen, E.L. (Oak Ridge Associated Universities, Inc., TN (USA). Inst. for Energy Analysis). Dec 1979. Contract EY-76-C-05-0033. 64p. Dep. NTIS, PC A04/MF A01.

Postwar trends in the West German economy, demography, and energy use were analyzed. The base year is 1976, and projections are made up to the year 2000 for gross domestic product (GDP) and sectoral energy demand. West Germany's 2.8% average annual GDP growth rate for the 1970s contrasts sharply with the 5.4% rate achieved in the 1960s. In part, this is due to a decline in the rate of capital formation from the level that prevailed in the 1960s. Also contributing to the drop in GDP growth has been a slower rate that reflects earlier retirements. Restrictions on immigration, imposed since 1975, mean that the slow domestic additions to the labor force will not be offset by migrants. The West German population decline is expected to persist as a consequence of the unusually low 1.5 to 1.6 total fertility rate. ORAU/IEA projects future GDP growth to level off at 2.9% a year, on the average, between now and 2000. This projection places German economic growth below that of Japan, Canada, and France but ahead of that projected for Italy and the United Kingdom. The relationship between West Germany energy demand and economic growth was stable in the postwar period. In 1976, total energy consumption stood at 9.8 quads and is projected to increase to 12.7 quads in 2000, an average annual 1.1 percent increase. The E/GDP ratio is expected to improve substantially by the year 2000, with the residential sector leading the way in energy efficiency.

12018 (ORAU/IEA—79-24(M)) **Canada: estimates of future energy/GNP relationships.** Allen, E.L.; Edmonds, J.A.; Williamson, R.B. (Oak Ridge Associated Universities, Inc., TN (USA). Inst. for Energy Analysis). Dec 1979. Contract EY-76-C-05-0033. 61p. Dep. NTIS, PC A04/MF A01.

The Canadian economy has been expanding at an annual rate of 4.6% in the 1970s (GNP growth), second only to the remarkable record of Japan. Economic development has been bolstered by supportive government policies, a high rate of domestic savings, and a continuing inflow of investment capital. The average annual increase in nonresidential fixed investment has been 6.5%, which is higher than in any other major industrialized nation. As a consequence, productivity, or output per worker, has not experienced the decline in growth which has been so striking in the US. In the future, Canadian economic development is expected to fall below past rates of achievement, primarily because of declining numbers of new entrants in the labor force. This trend will be only partially offset by higher female-participation rates. However, other factors affecting growth remain favorable. Canada, in particular, is virtually self-sufficient in energy. Government policy is to carry out a vigorous program of conservation, and to parallel this effort with domestic energy price increases which will move up to world levels over the next few years. As to economic growth, GNP expansion is expected to remain well above 3 percent a year for the balance of this century. Energy consumption is expected to grow from 7.51 Btu x 10^{15} (quads) in 1976 to 13.3 quads by 2000. This means that energy growth, as a consequence of determined conservation, is expected to be about half as rapid as economic growth to 1990.

12019 (ORAU/IEA—79-25(M)) **United Kingdom: estimates of future energy/GDP relationships.** Gehman, J.C.; Allen, E.L. (Oak Ridge Associated Universities, Inc., TN (USA). Inst. for Energy Analysis). Dec 1979. Contract EY-76-C-05-0033. 106p. Dep. NTIS, PC A06/MF A01.

The UK economy is expected to grow in real terms, due for the most part to advances in productivity. An increase in the labor-force-participation rate as a result of more women entering the labor force - to about 65% - should just offset a decline in the workweek. The latter is a result of a preferential shift to more leisure time and will reach 33 hours. With productivity increasing, but at a declining rate, real GDP is projected at 50% above the 1976 level. Turning to a sectoral analysis, the number of households is expected to increase by 15% as more individuals choose to live alone. The historical shift from goods production to services is expected to continue, but at a slower pace; by the year 2000 service output is expected to reach 55% of GDP. In the transport sector, the historical shift toward the passenger car is expected to saturate at about 70% of total ton-miles, while the shift toward struck freight is expected to continue and reach 76% of total ton-miles. Goods production is expected to stagnate and could fall to 33% of GDP by 2000. Historically, E/GDP has fallen steadily in the United Kingdom due almost exclusively to industrial conservation (investment in new and more-efficient plant and equipment). Conservation should spread to all other sectors of the economy as a result of government policy. The E/GDP ratio is expected to fall by another 28% by the year 2000. This implies total energy consumption of 8.7 quads.

12020 (PB—293550) **Oregon energy conservation plan in response to the Federal Energy Policy and Conservation Act of 1975 Public Law-94-163.** (Oregon State Dept. of Energy, Salem (USA)). 1977. 146p. NTIS PC A07/MF A01.

A partial listing of contents includes: energy use in Oregon - the need for conservation and resource development; an economic perspective - priorities for conservation and resource development; budget and funding; energy savings summary; mandatory requirements; detailed description of conservation and resource development plan; and environmental residuals summary.

12021 **Illinois petroleum shortage response plan.** Springfield, IL: Illinois Institute of Natural Resources (1979) 26p. (NP—24224).

This plan was drawn up in response to the petroleum shortage that occurred during the summer of 1979. It identifies a workable and effective response to short-term petroleum shortages. The plan is designed to reduce the demand for petroleum products in government and business facilities, on farms, in households, and for transportation purposes. (DLC)

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 11269, 11985, 11988, 11990, 11992, 11996, 12016, 12017, 12018, 12019

12022 (BNL—51086) **Methodology for coding the energy emergency management information system.** D'Acierno, J.; Hermelee, A.; Fredrickson, C.P.; Van Valkenburg, K. (Brookhaven National Lab., Upton, NY (USA)). Nov 1979. Contract EY-76-C-02-0016. 87p. Dep. NTIS, PC A05/MF A01.

The coding methodology for creating facility ID's and energy codes from information existing in EIA data systems currently being mapped into the EEMIS data structure is presented. A comprehensive approach is taken to facilitate implementation of EEMIS. A summary of EIA data sources which will be a part of the final system is presented in a table showing the intersection of 19 EIA data systems with the EEMIS data structure. The methodology for establishing ID codes for EIA sources and the corresponding EEMIS facilities in this table is presented. Detailed energy code translations from EIA source systems to the EEMIS energy codes are provided in order to clarify the transfer of energy data from many EIA systems which use different coding schemes. 28 tables.

12023 (CONS—3784-T1) **Energy in transition, 1985-2010. Final report of the Committee on Nuclear and Alternative Energy Systems, National Research Council.** (National Academy of Sciences, Washington, DC (USA)). 1979. Contract EX-76-C-10-3784. 820p. Dep. NTIS, PC A99/MF A01.

This exhaustive study, in assessing the roles of nuclear and alternative energy systems in the nation's energy future, focuses on the period between 1985 and 2010. Its intent is to illuminate the kinds of options the nation may wish to keep open in the future and to describe the actions, policies, and R and D programs that may be required to do so. The timing and the context of these decisions depend not only on the technical, social, and economic features of energy-supply technologies, but also on assumptions about future demand for energy and the possibilities for energy conservation through changes in consumption patterns and improved efficiency of the supply and end-use systems. The committee developed a three-tiered functional structure for the project. The first tier was CONAES itself, whose report embodies the ultimate findings, conclusions, and judgments of the study. To provide scientific and engineering data and economic analyses for the committee, a second tier of four panels was appointed by the committee to examine (1) energy demand and conservation, (2) energy supply and delivery systems, (3) risks and impacts of energy supply and use, and (4) various models of possible future energy systems and decision making. Each panel in turn established a number of resource groups - some two dozen in all - to address in detail an array of more particular matters. Briefly stated, recommended strategies are: (1) increased energy conservation; (2) expansion of the nation's balanced coal and nuclear electrical generation base; (3) retention of the breeder option; (4) stimulation of fluid energy development; and (5) immediate increase in research and development of new energy options to ensure availability over the long term.

12024 (INIS-mf—5212) **Energy research. The Trade Ministry's energy research program. Status report by the end of 1978.** (Energistyrelsen, Copenhagen (Denmark)). Mar 1979. 216p. (In Danish). Dep. NTIS (US Sales Only), PC A10/MF A01.

Status reports are given for the Danish Trade Ministry's energy research projects on uranium prospecting and extraction, oil and gas recovery, underground storage of district heating, electrochemical energy storage systems, wind mills, coal deposits, coal cambustion, energy consumption in buildings, solar heat, biogas, compost heat.

12025 (JPL-PUBL—78-56, pp 33-36) **Systems examination of the opportunities of coal for California.** Hathaway, W.M. (Fluor Engineers and Constructors, Inc., Irvine, CA). 15 Aug 1978.

From Conference on coal use for California; Pasadena, CA, USA (9 May 1978).

Appreciable empirical evidence has been published which indicates a strong correlation between a society's economic wealth (its GNP) and its energy consumption. With a growing population and increasing individuals' aspirations, California's energy demands will also rise in the future. Because of decreasing availability of petroleum fuels and natural gas, it is imperative that alternative means be developed for meeting these demands. In this paper we examine the options available for importing energy derived from coal. These include: (1) electric power generated from coal, (2) coal gasification near the mine site for conversion to substitute natural gas or liquid products such as methanol or hydrocarbons, (3) converting the coal directly to liquid hydrocarbons similar to a synthetic crude oil. Comment is made on the long lead times required between conception and completion of facilities of this type. Because of political and economic impediments, excessive delays have resulted in cancellation of projects such as Kaiparowits and WESCO. The need for statesmen and citizens with vision and courage to act is emphasized.

12026 (JPL-PUBL—78-56, pp 49-52) **Electric energy demand and supply prospects for California.** Jones, H.G.M. (California Energy Commission, Sacramento). 15 Aug 1978.

From Conference on coal use for California; Pasadena, CA, USA (9 May 1978).

The debate over forecasts of electricity demand in California has been going on before the California Energy Commission for over two years, and before the Public Utilities Commission and State Legislature for over five years. This debate on electrical demand forecasts was engendered by the strong environmental protection sentiments of the late 1960's, most notably spurred on by the Santa Barbara Channel oil spill. There was further a belief in some quarters that California utilities were overexpanding and might fill the coastline with nuclear power plants. The adoption of the Federal Clean Air Act Amendments, the National Environmental Policy Act (NEPA), and the California Environmental Quality Act, all in 1969, and the establishment of the California Coastal Zone Commission in 1972, signalled a major environmental movement to regulate utility growth. The debate over electrical forecasts has not been eliminated. The California Energy Commission prepared statewide electricity demand forecasts with assistance and critical review from the State's five major utilities. The Commission officially adopted a most likely forecast for use in approving new generation facilities. While the forecast remains controversial, it is the first fully documented electricity demand forecast offically adopted as a basis for approving on a statewide basis proposals to construct new generation stations.

12027 (JPL-PUBL—78-56, pp 53-55) **Coal's role in California's energy needs.** Daines, N.H. (Pacific Gas and Electric Co., San Francisco, CA). 15 Aug 1978.

From Conference on coal use for California; Pasadena, CA, USA (9 May 1978).

California's post-industrial society demands confidence in the energy supply system as an essential ingredient for societal harmony and adequate job creating capital investment. Confidence requires policies which balance supply and demand using believalbe methods with adequate allowance for the unexpected, reliance on diverse sources and locations, respect for our environment, sustain our individual freedoms and provide opportunities for economic mobility. Coal will play only a part, but an important part, in a multifaceted energy policy using numerous energy sources and systems, conservation techniques, and cooperating social institutions. Today's extensive and challenging research and development provides the foundation for future technologies which will further resolve the environmental effects associated with coal.

12028 (JPL-PUBL—78-56, pp 56-60) **Energy supply and demand in California.** Griffith, E.D. 15 Aug 1978.

From Conference on coal use for California; Pasadena, CA, USA (9 May 1978).

California energy policy makers face a number of critical choices during the next few years that will impact both energy supply and energy demand over several decades. The pivotal choices, and those with greatest long range impact, are probably those decisions related to electric generating capacity, especially the choice of building nuclear and/or coal fired power plants. Decisions that result in inadequate new generating capacity will probably result in increased demand for oil and gas, fuels that are likely to be both scarce and expensive in coming decades. While it is clear that we must work to develop solar, geothermal, and other renewable forms of energy as rapidly as possible, prudent planners and policy makers cannot assume good luck in their development. The long-run transition to renewable energy requires vigorous development of fossil fuel resources and electricity generation from coal and/or nuclear energy to see us through the next several decades. To be truly effective, California energy policies need to balance these near-term and long-term goals, while recognizing the many uncertainties and unknowns that are involved in attempting to make any assessment about the future. Finally, California energy policies will be most effective if they reflect both the national and international energy situation. California is no more capable than any other states of going it alone on energy policy. We are major importers of both crude oil and natural gas and will continue to be so in the future. It is important that California develop policies that are both pragmatic and responsible in meeting the needs of her own citizens while reflecting the national and international nature of energy problems.

12029 (UT/CES-PS—8) **Yugoslavia's energy supplies: constraints and outlook.** Hoffman, G.W. (Texas Univ., Austin (USA). Center for Energy Studies). Nov 1979. 68p. Dep. NTIS, PC A04/MF A01.

This report describes Yugoslavia's changing energy-supply situation, emphasizing the current use pattern of its resources, its production, and the problems created by the country's structural and regional imbalances. The report considers the impact of an ever-increasing dependence on foreign imports. The study analyzes the impact of the under-fulfilled goals of the 1976-1980 Plan on the establishment of a viable long-term energy policy for the country and suggests some essential solutions to the country's energy problems.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 11136, 11576, 11989, 11996, 12006, 12023, 12029, 12105, 12135, 12543

12030 (CONF-781108—, pp 53-65) **Ranking energy policy alternatives in a partially informed population.** Urquhart, N.S.; Eastman, C.E. (New Mexico State Univ., Las Cruces). Jul 1979.

From 4. DOE statistical symposium; Albuquerque, NM, USA (1 Nov 1978).

A policy maker needs to consider several perspectives in arriving at a decision. When the perspectives need to include a population's attitude toward the relative desirability of the alternatives, an evaluation problem occurs. An obvious approach is to ask a sample of people from the population to rank the alternatives. This approach encounters a problem for some respondents: they cannot (or will not) order the alternatives. However, we have found that most respondents will identify the preferred alternative when alternatives are posed pairwise. This paper describes the analysis of such data and reports results of a survey of attitudes toward energy policy matters conducted throughout New Mexico in the summer of 1977. If a person has a well-defined ordering for the alternatives, the number of times he prefers each alternative will give his ordering. Ties in numbers of preferences correspond to ties among the alternatives except for certain illogical and rarely occurring outcomes. Thus the Friedman rank procedure can be adapted to provide a valid analysis and the basis for multiple comparisons like an LSD. The number and nature of the ties index the respondents' and the population's indecisiveness about the alternatives. The latter point is needed: individual rankings are aggregated to draw inferences from the sample to the population. This aggregation loses information about consistency of individual rankings.

12031 (DOE/ERA—0022) **Procedures for termination of electric service and gas service. Guideline No. 1 under the Public Utility Regulatory Policies Act of 1978.** (Department of Energy, Washington, DC (USA). Economic Regulatory Administration). Dec 1979. 40p. Dep. NTIS, PC A03/MF A01.

Section 113 (b) (4) of Title I of PURPA establishes a standard on Procedures for Termination of Electric Service for State regulatory authorities and certain nonregulated utilities. The standard applies to those electric utilities whose annual retail sales exceed 500 million KW in any calendar year beginning after December 31, 1975, and before the immediately preceding calendar year. A similar Federal policy standard is established by section 303 (b) (1) of Title III of PURPA for gas utilities: those utilities whose annual retail sales exceed 10 billion cubic feet during any calendar year beginning after December 31, 1975, and before the immediately preceding calendar year. This notice summarizes in the Preamble the public comments DOE received and presents the guideline in its final form as the Appendix. (MCW)

12032 Report of the Asia-Pacific energy studies conference. Honolulu, HI; East-West Resource Systems Institute (1978). 112p. (CONF-780798—).

From Asia-Pacific energy studies conference; Honolulu, HI, USA (26 Jul 1978).

A three-day conference was held to examine the possibility of establishing a non-governmental, Asia-Pacific area consortium for energy studies. The activities and recommendations of various committees at the conference are summarized. Participants at the meeting agreed that such a consortium should be established and recommended steps for achieving his goal. (LCL)

12033 Power plant siting policy paper. Sacramento, CA; California Energy Commission (1978). 112p. (NP—24095).

The California Energy Commission has initiated a general rulemaking proceeding whose goal is to develop and adopt a comprehensive set of regulations to guide the review of proposals to construct new thermal electric power plants and electric transmission lines. The paper identifies the major components of the Warren-Alquist Act's overall regulatory scheme and attempts to define the roles, purposes and objectives of each component. The paper focuses on the emphasis placed in recent legislation on the Biennial Report as an essential analytical tool for rationalizing the siting process. The paper also attempts to define more concretely the statutory tests which a siting proposal must satisfy in order to gain Commission approval and certification. (ACR)

FOSSIL FUELS

REFER ALSO TO CITATION(S) 11197, 11897, 12022

COAL

REFER ALSO TO CITATION(S) 11116, 11123, 11138, 11139, 11183, 11200, 11202

12034 Synthetic fuels cheaper than oil. *EPRI J.;* **4**: No. 9, 18-23(Nov 1979).

A price comparison of fuel oil from imported crude and synfuel from domestic coal indicates that synthetic fossil fuels should be cheaper if oil prices continue to escalate and if production occurs at mature commercial plants. An economic analysis made by the Electric Power Research Institute (EPRI) estimates the various synthetic fuel prices that will result from five financial incentives. The report concludes that, in order to stimulate the development of a synfuel industry, tax and price incentives that cause the least distortion of fuel and capital markets are needed. EPRI also concurs with the need for a fast-track program of licensing and permits for the reduction plants.

PETROLEUM

REFER ALSO TO CITATION(S) 11205, 11207, 11227, 11229, 11246, 12085

12035 (EMD—79-41) **Onshore oil and gas leasing: who wins the lottery.** Staats, E.B. (General Accounting Office, Washington, DC (USA)). 13 Apr 1979. 21p. General Accounting Office, P.O. Box 6015, Gaithersburg, MD.

Presently, most of the 114,000 onshore oil and gas leases for over 93 million acres of Federal land are awarded under a lottery system. GAO was asked to review alleged irregularities in this leasing, administered by the Department of the Interior (DOI). GAO's review of drawings in New Mexico and Wyoming detected no indication of manipulation, but showed weaknesses in controls which allow the possibility for it. Basic changes, including possible alternatives to the system, are under study by DOI.

12036 (LA—8158-MS) **Analysis of bidding data on offshore oil lease sales.** Conover, W.J.; Iman, R.L.; Pavur, R.; Bruckner, L.A. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 33p. Dep. NTIS, PC A03/MF A01.

Several types of statistical analyses are reported on the bidding data for offshore oil leases in the five sales from 1954 to 1967, in an attempt to obtain a method for identifying leases that become productive. These methods include using standardized variables, nonstandardized variables, stepwise regression on the variables, stepwise regression on the ranks of the variables, maximum likelihood estimation of the parameters, PRESS, and metroglyphs. While the methods using ranks seem to identify the producers a higher percentage of the time, the methods using the data are more accurate in identifying nonproducing leases. The percentage of correct classification was usually in the 60 to 70 percent range for all methods attempted. No single variable seems to be a consistently accurate predictor of whether a lease will be a producer or a nonproducer.

12037 DOE's implementation of crude oil and product allocation programs. Dewton, D. (DOE, Washington, DC). *Natl. Pet. Refin. Assoc., (Tech. Publ.);* 8(1979).

The U.S. Department of Energy, through its regulatory arm, the Economic Regulatory Administration (ERA), continues to be involved extensively in the implementation of allocation programs for crude oil and petroleum products. The focus of this discussion is to provide an overview of the activities of DOE with respect to petroleum allocation programs, particularly as they have evolved since the disruption of Iranian oil supplies in 1978. Specific topics include: ERA implementation of petroleum allocation programs prior to the Iranian disruption; recent proposal of standby mandatory crude oil and petroleum product allocation and price programs for use in an emergency; impact of Iranian supply disruption on world market and International Energy Agency response; DOE's monitoring of the supply/demand balance in the U.S.; U.S. supply/demand overview and price effects; recent implementation of DOE regulatory authorities; additional areas of regulatory planning; and importance of voluntary conservation.

NATURAL GAS

REFER ALSO TO CITATION(S) 11207, 11251, 11269, 11995, 12031, 12035

12038 (NTIS/PS—79/0701) **Natural gas: supply, demand and utilization. volume 2. 1976-1977 (a bibliography with abstracts). Report for 1976-77.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Jul 1979. 229p. NTIS PCN01/MF N01.

Abstracts pertaining to natural gas supply and demand, industrial and residential consumption, fuel substitution, availability, costs,

Government policies, and regulations are presented. Studies dealing with projections of natural gas use and the economics of supply and demand are included. (This updated bibliography contains 220 abstracts, none of which are new entries to the previous edition.)

12039 (NTIS/PS—79/0702) **Natural gas: supply, demand and utilization. volume 3. 1978-June, 1979 (a bibliography with abstracts). Report for 1978-Jun 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Jul 1979. 116p. NTIS PCN01/MF N01.

Abstracts pertaining to natural gas supply and demand, industrial and residential consumption, fuel substitution, availability, costs, Government policies, and regulations are presented. Studies dealing with projections of natural gas use and the economics of supply and demand are included. (This updated bibliography contains 107 abstracts, 75 of which are new entries to the previous edition.)

OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 11274, 11284

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 12034

ELECTRIC POWER

REFER ALSO TO CITATION(S) 11628, 12031, 12090, 12091, 12092, 12095, 12100, 12101, 12102, 12103, 12104

12040 (DOE/EIA—0041/1Q(78)) **National trends in electric energy resource use. Energy data reports. First quarter, 1978.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Nov 1978. 44p. Dep. NTIS, PC A03/MF A01.

National trends in the use of electric energy resources for the production of electric power for the first quarter of 1978 are summarized. The report indicates that electric power generation in the first quarter was 3.1% greater than generation in the first quarter of 1977, and approximately 5.2% greater than that in the fourth quarter of 1977. The information is based on data obtained from four monthly forms retained from the former Federal Power Commission: No. 4 (power production, fuel consumption, and fuel stocks information); No. 5 (electric operating revenues and income); No. 12E-2 (energy capability and peak load data); No. 423 (cost and quality of fuels). The graphs are designed to permit trends to be quickly identified while enabling comparison of the trends with those of the previous year. The graphs contain six units of information: net generation; fuel consumption and stockpiles; fuel deliveries; fuel costs; monthly net energy for load and monthly peak loads by regional reliability councils; sales of electric energy.

12041 (DOE/EIA—0046/7(78)) **July 1978 sales, revenue and income for electric utilities: Energy data report.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Oct 1978. 8p. Dep. NTIS, PC A02/MF A01.

Tabulated data are presented for: (1) sales, revenues, and income for July 1977 and July 1978; (2) twelve month total sales, revenues, and income for tweve month periods ending July 1977 and July 1978; and (3) monthly sales of electric energy to ultimate consumers. (TFD)

12042 (DOE/ERA/6385—1) **Power pooling: issues and approaches.** (Resource Planning Associates, Inc., Cambridge, MA (USA)). Jan 1980. Contract EB-78-C-01-6385. 142p. Dep. NTIS, PC A07/MF A01.

Power pools consist of two or more electric-utility systems that coordinate planning and operations to achieve economies of scale, minimize operating cost, conserve fuel, and increase the reliability of their bulk power-supply systems. Presently, 38% of the electricity consumed in the US is generated by interconnected utilities with formal, pool-wide agreements. DOE's Economic Regulatory Administration has begun a comprehensive program to encourage coordination among electric utility systems. This report covers procedures and agreements adopted by four power pools: the Florida Electric Power Coordinating Group; the New York Power Pool; the Pennsylvania-New Jersey-Maryland Interconnection; and the New England Power Pool. (MCW)

12043 (NP—24239) **Electric Utility Rate Design Study: a procedure for developing electric-utility rates based upon time-differentiated accounting costs.** (Putnam, Hayes and Bartlett, Inc., Newton, MA (USA)). 26 Nov 1979. 203p. EPRI, Palo Alto, CA.

Phase I of the Electric Utility Rate Design Study observed that the procedures for time-differentiated costing using accounting costs need further logical development and documentation. As part of a continuing research effort in Phase II, Putnam, Hayes and Bartlett, Inc., was assigned to develop a methodological framework for rates based upon time-differentiated accounting costs. This report provides documentation of that research effort. A six-step procedure was developd as follows: utilization of an embedded cost of service study; selection of rating periods; development of allocation factors for demand-related costs; development of allocation factors for energy-related costs; computation of unit costs; and specification of rate schedules. The six sections of the report focus upon the specification and application of each step of this methodology, in order, to Virginia Electric and Power Company (VEPCO) and Ontario Hydro (HYDRO).

12044 (NP—24255) **Electric Utility Rate Design Study: an evaluation of four marginal-costing methodologies.** (Temple, Barker and Sloane, Inc., Lexington, MA (USA)). 13 Jul 1979. 109p. EPRI, Palo Alto, CA.

The four marginal-costing methodologies most frequently considered for the US electric utility industry are evaluated for the Electric Utility Rate Design Study. A number of previously unanalyzed similarities among the methodologies and several critical issues which remain to be resolved are identified. The methodologies generally referred to by the authors' names, are: Cicchetti, Gillen, and Smolensky; Ernst and Ernst; Gordian Associates; and National Economic Research Associates. The rate designer's selection of a marginal costing-methodology should be guided by a thorough understanding of the relative advantages of each methodology. This report provides a consistent description and comparison of the methodologies.

12045 (NP—24256) **Electric Utility Rate Design Study: a comparison of rate design alternatives developed by Ebasco Services and National Economic Research Associates for the Virginia Electric and Power Company.** (Temple, Barker and Sloane, Inc., Lexington, MA (USA)). 19 Mar 1979. 60p. EPRI, Palo Alto, CA.

Time-differentiated rates prepared for Virginia Electric and Power Company as part of the Electric Utility Rate Design Study are analyzed. The report identifies major causes of differences in costs and rates developed by Ebasco Services, Inc., and National Economic Research Associates. The differences are noted. The study further determines the extent to which differences in the Ebasco and NERA results are attributable to differences in data, judgment, and alternative rate design procedures. (MCW)

12046 (ORNL/Sub—77/13509/5) **Survey of utility load management and energy conservation projects. 2nd revised report.** (EUS, Inc., Pittsburgh, PA (USA)). Nov 1979. Contract W-7405-ENG-26. 523p. Dep. NTIS, PC A22/MF A01.

In the December 1977 publication of the Survey Part 1, 50 utility-sponsored thermal energy storage (TES) projects and 41 communication and load control (C and LC) projects were summarized. In the April 1978 publication of the Survey Part 2 (EAPA 4:4836), 43 utility-sponsored energy conservation programs were summarized. The 1st Revised Report (EAPA 5:2973), published in December 1978 included descriptions of 21 new TES, 22 new C and LC, and 27 new conservation projects. Also included were those 134 project summaries found in the original Parts 1 and 2 many of which were revised based on responses from a mailing to the utilities concerned. Sections 1 and 2 of this report represent a departure from the format found in the previous Surveys. The projects described in these two sections are grouped into subsections according to the type of TES or C and LC system or device utilized. Each subsection is preceded by a technical discussion of the particular system or device followed, where applicable, by a listing and description of available manufactured equipment. A total of 29 new, 36 revised, and 15 unrevised TES projects and 36 new, 31 revised, and 26 unrevised C and LC projects are described in Sections 1 and 2. All revised projects appear in full summary form as do those new projects that are significant and non-duplicative in terms of scope, equipment used, and/or results. All other projects are included in summary tables found in each respective subsection.Section 3 of this report contains detailed project summaries of 9 new, 42 revised, and 27 unrevised utility-sponsored energy-conservation projects.

12047 **Potential solution for power-pooling roadblocks.** Littell, R.; Neises, K.J. *Public Util. Fortn.;* **104**: No. 13, 23-26(20 Dec 1979).

The Energy Mobilization Board concept, which is moving towards final congressional action, can set a pattern for resolving Federal-state confrontations over electric power pool development, these authors believe. At the present time, no single governmental body exercises full and complete power over the regional development of electric power. Both the Federal government and the states have the power to encourage - or hinder - the establishment and operations of power pools. This fragmentation of authority carries with it a real potential for state and Federal confrontations which can delay full realization of the benefits of power pooling. If Congress can overcome reluctance to intrude on state prerogatives, the board can expand its presently planned ability to cut red tape.

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 11642, 11839, 12004, 12005

ELECTRIC POWER TRANSMISSION AND DISTRIBUTION

12048 (PB—293059) **Electric energy supply in the New York area: environmental damage, economic development and the political decision-making process. Final report, 1 September 1972-31 August 1974.** (New York Regional Energy Study, NY (USA)). 1 Apr 1975. 95p. NTIS, PC A05/MF A01.

The possible impact of areawide residential location policy on future residential electricity usage in the Tri-State Metropolitan Region centering on New York City is investigated. At the outset this project was devoted to testing a number of hypotheses: that the growth of the electric energy supply in New York was likely to fall short of demand because of insufficient generating capacity, that the resulting effects might make a case for relaxing environmental standards, that management of supply would be essential, and that governmental processes were not dealing effectively with the problem. The energy crisis, though, has changed the hypotheses. The limits to the power supply are much more likely to be a function of the price of fuels, and there is a much greater price elasticity of demand for electricity than was initially expected. Thus, in midstream this project changed its focus to the consequences of higher electricity prices in terms of electricity use, residential location, and economic development. It has produced estimates and projections of effects which have policy implications, but not policy answers.

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 12029, 12073, 12075, 12084, 12116

12049 **Does the United States waste energy.** *EPRI J.;* **4**: No. 9, 26-32(Nov 1979).

Sociological differences that affect how groups of people live and allocate their resources are found to be basic to any discussion of relative wastefulness. International statistics that compare the US unfavorably with countries of equal living standards are reexaminated in a regional context and found to be only partially applicable. Confusion between the terms energy efficiency and economic efficiency has led to what the author calls an unbalanced interpretation given to US per capita energy consumption and to the omission of price as a determinant. A more-complete interpretation follows if national economic infrastructures are compared and consideration is given to the individual economic decisions which determine not only how energy is used but how money is allocated for energy use. The US can learn from some of the experiences of Sweden, West Germany, and Japan, however, as energy prices go up and the country can make appropriate adjustments.

12050 **ORNL residential energy-use model: structure and results.** Hirst, E.; Carney, J. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Land Econ.;* **55**: No. 3, 319-333(Aug 1979).

The Residential Energy-Use Model at the Oak Ridge National Laboratory is used to analyze the effects of various conservation policies and techniques on costs and uses over time. Four fuels, eight end uses, and three housing types provide inputs to a simulation of national annual energy use. Each component is further subdivided and analyzed to make the model sensitive to demographic, economic, and technological factors and to show the effects of different energy-conservation options. 31 references.

UNCONVENTIONAL SOURCES AND POWER GENERATION

REFER ALSO TO CITATION(S) 11642

12051 (PB—290419) **Natural energy and living, Number 2, 1978.** Todd, B.; Mullet, P.; McRobie, G.; McClory, P. (Natural Energy Association, Kingston upon Thames (UK)). 1978. 53p. NTIS, PC A04/MF A01.

This small booklet will be of interest to those who are involved in the uses of natural energy. The booklet is the second in a series of four issues on the innovative uses of natural energy. Featured in the booklet are articles on low energy use housing; the need for alternative energy technology; hydrophonics; solar heat; the Windscale Follies and the advisability of setting up nuclear fuel reprocessing plants in the north of England; and a home built using solar panels, a wind generator, diesel set, and a steam engine.

12052 **Renewable energy for the world's poor.** Ashworth, J. (Solar Energy Research Inst., Golden, CO). *Technol. Rev.;* **82**: No. 2, 42-49(Nov 1979).

Non-commercial organizations are largely responsible for the introduction of renewable energy sources into rural areas of developing countries, where energy demand is limited to providing basic human needs. The more industrialized of the developing countries were able to meet rising oil prices by lowering oil consumption and borrowing from commercial banks; but the poorer nations, unable to reduce already-minimal consumption levels, turned to multilateral and bilateral agencies for help. Third World criticism of the development community's reliance on Western-type electric power and the special problems of rural areas prompted the search for more appropriate technologies and a cautious funding of demonstration projects of both the transplant and implant concepts. The process of selecting technologies that are locally appropriate and acceptable is made difficult because market forces are lacking. Four criteria are suggested for improving the selection process. 20 references.

SOLAR

REFER ALSO TO CITATION(S) 11431, 11434, 11650, 12054

GEOTHERMAL

REFER ALSO TO CITATION(S) 11712, 11713, 11722, 11723, 11744, 11745, 11746, 11747, 11748, 11749, 11762, 11764, 11776, 11807

12053 (DOE/ID/12017—1) **New Mexico geothermal commercialization planning. Semi-annual progress report, January 1, 1979-June 30, 1979.** Rodriguez, P.; Scudella, G.; Fedor, D. (New Mexico Energy and Minerals Dept., Santa Fe (USA)). 1979. Contract FC07-79ID12017. 124p. Dep. NTIS, PC A06/MF A01.

The market potential for geothermal energy development in New Mexico is estimated. Barriers to market penetration and geothermal development initiatives were identified. Statutes and regulations affecting geothermal development are appended.

OTHER

REFER ALSO TO CITATION(S) 11576, 11577, 11580, 11815, 12546, 12591, 12592

12054 (PB—290420) **Natural energy and living, Number 3, 1978.** Clark, R.; Cooley, M.; Hobbs, M.; Jones, A. (Natural Energy Association, Kingston upon Thames (UK)). 1978. 60p. NTIS, PC A04/MF A01.

This booklet discusses the latest developments in the field of natural energy. The emphasis is on a simple, efficient, and ecology-minded technology. There is a round-up of current events occurring in natural energy plus features on solar cells, wood burning stoves, the land bond plan, and a technology for workers. Anyone interested in natural energy may find this booklet informative.

ENERGY CONVERSION

REFER ALSO TO CITATION(S) 11813, 12207

12055 **Thermodynamics of direct energy conversions.** Rahman, A.A. (Oakland Univ., Rochester, MI). pp 136-140 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

In this work, a generalized thermodynamic analysis was developed for direct energy converters that operate as heat engines. Examples for various converters as thermoelectric MHD and Nernst generators are solved. The possibilities of utilizing these concepts on designing generators to convert heat or solar energy directly into electricity are also discussed.

MHD GENERATORS

REFER ALSO TO CITATION(S) 12055, 12869

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 11575

12056 (CONF-790640—7) **Open-cycle coal-fired liquid-metal MHD.** Pierson, E.S.; Petrick, M.; Schreiner, F.; Cohen, D. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 12p. Dep. NTIS, PC A02/MF A01.

From 18. symposium on engineering aspects of magnetohydrodynamics; Butte, MT, USA (18 Jun 1979).

Open-cycle, coal-fired, liquid-metal MHD combines the simplicity of using the coal combustion products directly as the thermodynamic working fluid in the energy-conversion process with the moderate temperatures and inherent high thermodynamic efficiency of the two-phase liquid-metal MHD cycle. This new concept is described and compared with the open-cycle plasma MHD cycle, and it is shown that, in the former, temperatures are much lower and the air preheater and radiant boiler are eliminated. The constraints on the electrodynamic working fluid and the choice of copper are discussed. Recent experiments with liquid copper and coal combustion gas are described, and the indicated implications for environmental impact, i.e., SO/sub x/ and NO/sub x/ control, are discussed. Initial efficiency calculations yield values comparable to those for open-cycle plasma MHD at combustor temperatures as much as 1000 K lower and MHD generator temperatures more than 1000 K lower than is the case for open-cycle plasma MHD. Significantly, the liquid-metal MHD system uses components that, except for the generator, are close to or within present-day technology, and it appears that readily-available containment materials are compatible with the fluids.

12057 (CONS—2895-3) **Report on the MHD performance demonstration experiment, October 1, 1977-September 30, 1978.** Schmidt, H.J.; Starr, R.F.; Lineberry, J.T.; Whitehead, G.L.; Seiber, B.L. (Arnold Engineering Development Center, Arnold Air Force Station, TN (USA)). Apr 1979. Contract ET-78-I-01-2895. 155p. Dep. NTIS, PC A08/MF A01.

The Arnold Engineering Development Center (ALDC) has been under contract since December 1973 to modify existing equipment and to design, fabricate, and install new hardware to perform an MHD Performance Demonstration Experiment. The objective of the experiment is to demonstrate that a generator simulating a commercial-sized device can convert 16 to 18 percent of the available thermal energy into electrical power. This report described fabrication, installation, and testing of hardware for this experiment during the period from October 1, 1977, to September 30, 1978. In the past year, fabrication of the high performance generator channel was completed, and satisfactorily pressure and electrically checked. The coils and approximately 95 percent of the coil force containment structure were installed on the 6 Tesla magnet. Fabrication of the outer insulation panels for the magnet was completed. The magnet is to be cryogenically cooled with liquid nitrogen. During the past year, analytical studies to provide guidance in performing the cooldown were completed and are presented. The preliminary design of the cooling manifold system to provide the required control in accordance with the results of the analytical studies was also completed and is reported. Additional testing of the burner system with the diagnostic section installed was conducted and the results for seeded and unseeded operation are included.

12058 (FE—1760-37) **MHD coal-fired flow facility. Quarterly technical progress report, January-March 1979.** Dicks, J.B.; Markant, H.P.; Crawford, L.W. (Tennessee Univ., Tullahoma (USA). Space Inst.). 21 Mar 1979. Contract EX-76-C-01-1760. 45p. Dep. NTIS, PC A03/MF A01.

The overall objective is to advance the technology of direct coal-fired MHD components and systems required for MHD power systems operating under engineering simulation of central power station power conditions. The specific objectives of the UTSI R and D MHD Facility and the MHD Coal-Fired Flow Facility are to resolve experimentally and analytically the key technical problems which have been identified or which may be found to occur in direct coal-fired MHD systems with moderate to high ash carryover. The problem areas involve (1) combustor performance, (2) slag/seed separation, (3) seed separation efficiency from both the exhaust gas stream and from slag, (4) MHD generator performance and design requirements using slag deposition on the channel walls to protect these walls from the intense thermal environment, (5) effects of slag on freedom from serious plugging by solid or high-viscosity slag particles during normal operation, (6) response of candidate materials to direct coal-fired MHD environment, and (7) equipment to meet pollution requirements. Status of the program is reported. (WHK)

12059 (FE—2363-4) **MHD ETF-150 MW progressive facility reference concept.** (Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.). Aug 1979. Contract EF-77-C-01-2363. 335p. Dep. NTIS, PC A15/MF A01.

The objectives of this study were to develop a progressive program plan for a 150 MWt MHD engineering test facility. The facility was to start with a minimal MHD power train system which utilized a proven separately fired air preheater with oxygen enhancement as needed. It was to be capable of progressive evolvement into a final configuration which included all of the pertinent systems necessary to demonstrate the open cycle MHD combined cycle plant in a 150 MWt size. Cost, risk, schedule, performance effects and component usefulness in various phases of the progressive plan were to be evaluated. The previous 150 MWt Reference ETF Design Study results were to be utilized as a starting point for this study. Inasmuch as possible, current state-of-the-art components were to be used (as long as they did not compromise the performance or limit the ability to determine the potential of the MHD system). Direct or indirect preheat options were to be available in the final configuration. The flexibility to accommodate changes in components, substitute equipment and allow for uncertainties existing in developing equipments was to be provided. No steam driven generator was to be included although the required steam conditions necessary for such a bottoming plant were to be demonstrated. The system should in its final configuration utilize coal as its energy source, although oil or gas could be maintained as options for the separately fired air preheater combustor. The results of this study are to provide guidance for and recommend the most logical plan by which the maximum information from plant design demonstration and operating performance could be obtained. Assessment of the various arrangements of the components and systems configurations is to provide guidance for the definition of priority development efforts needed for design and construction of the ETF.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 12057

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 12057, 12059

12060 (FE—2688-T1) **Investigation into the commercial application of first generation MHD power plants to the aluminum industry.** Dooley, M.T.; Carter, L.D. (Ternion, Inc., Denver, CO (USA)). Oct 1978. Contract ET-78-C-01-2688. 51p. Dep. NTIS, PC A04/MF A01.

The United States has embarked on an ambitious program to develop open-cycle, coal-fired MHD-topped steam power generation plants to commercialization by the end of this century. The results of a study on the commercial application of the first generation MHD power plants to the aluminum industry are reported. The basic processes and energy requirements of the aluminium industry are reviewed, and the operation of coal-fired combined-cycle MHD power plants is described. Dual-purpose MHD power plants are considered. (WHK)

12061 (PNL-SA—7619) **Performance of US electrodes-insulators tested in the USSR U-02. Phase III.** Bates, J.L.; Daniel, J.L.; Rossing, B.; Sadler, J.W.; Hosler, W.; Negas, T. (Battelle Pacific Northwest Labs., Richland, WA (USA); Westinghouse Electric Corp., Pittsburgh, PA (USA); National Bureau of Standards, Washington, DC (USA)). 1979. Contract EY-C-06-1830. 10p. (CONF-790640—8). Dep. NTIS, PC A02/MF A01.

From 18. symposium on engineering aspects of magnetohydrodynamics; Butte, MT, USA (18 Jun 1979).

The performance of $La(Mg)CrO_3$ and $La(Mg)CrO_3$. ZrO_2-base electrodes, MgO and $MgAl_2O_4$ electrical insulators, and nickel-mesh compliant attachments (US-USSR test in U-02 Phase III) has been evaluated. The nickel mesh provided satisfactory electrical, thermal, and thermomechanical attachment. Major degradation of cathodes is attributed to enhanced electrochemical reaction of K_2CO_3 midway between surface and attachment and ultimate hydration of reaction products. Extensive plasma surface reactions with Al_2O_3, introduced into channel by plasma from upstream components, caused extensive reaction with electrodes and insulators, surface flow, and bridging between electrodes. Chromium loss occurred near electrode surface due to thermal instability of $LaCrO_3$. The monolithic MgO and $MgAl_2O_4$ insulators fractured with seed penetration through the cracks. Loss of electrical isolation between electrodes attributed to this seed penetration and electrode surface bridging.

12062 (PNL-SA—7620) **Development of electrodes based on yttrium chromites and rare earth doped hafnia for MHD generator applications.** Marchant, D.D.; Bates, J.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Oct 1979. Contract EY-76-C-06-1830. 8p. (CONF-790640—9). Dep. NTIS, PC A02/MF A01.

From 18. symposium on engineering aspects of magnetohydrodynamics; Butte, MT, USA (18 Jun 1979).

Yttrium chromites are being studied as potential high temperature electrodes for MHD. Like lanthanum chromites, the doped yttrium chromites have similar high electrical conductivity, predominantly electronic over a wide temperature range; however, they do not form hydroscopic decomposition products, which cause gross structural degradation. In addition, they exhibit substantially improved resistance to electrochemical attack by slag/seed. The electrical conductivity, thermal diffusivity/conductivity, melting points, thermal expansion, vaporization and electrochemical corrosion for several yttrium chromite compositions are reported and compared with analogous lanthanum chromites. Hafnium oxide containing rare earth additions are also being studied as potential high temperature MHD electrodes. The electrode compositions show a high resistance

to electrochemical corrosion in slag/seed. Hafnia-rare earth-M_2O_3 oxides can be fabricated with sufficient room temperature electrical conductivity to make them candidates for ceramic-to-metal current leadouts. Electrochemical tests of ceramic current leadout: ceramic electrode couples have been conducted at high temperatures and with high current densities for long periods of time with little interaction between the electrodes and leadouts.

12063 Superconducting dipole magnet for the UTSI MHD facility. Wang, S.T.; Niemann, R.C.; Turner, L.R.; Genens, L.; Pelczarski, W.; Gonczy, J.; Hoffman, J.; Huang, Y.C.; Modjeski, N.; Kraft, E. (Argonne Natl Lab, Ill). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 302-305(Jan 1979).

The Argonne National Laboratory is designing and will build a large superconducting dipole magnet system for use in the Coal Fired Flow MHD Research Facility at the University of Tennessee Space Institute (UTSI). The conceptual design of the magnet geometry, conductor design, cryostability evaluation, magnetic pressure computation, structural design, cryostat design, and the cryogenics system design are presented.

THERMOELECTRIC GENERATORS

REFER ALSO TO CITATION(S) 12055

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 11575

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 11396

MATERIALS, COMPONENTS, AND AUXILIARIES

12064 (MMM—2331-0642) **Thermoelectric Materials Evaluation Program. Annual technical report for fiscal year 1979.** Hinderman, J.D. (Minnesota Mining and Mfg. Co., St. Paul (USA)). Oct 1979. Contract EY-76-C-02-2331. 137p. Dep. NTIS, PC A07/MF A01.

Optimization was initiated with respect to performance, operating temperatures, and thermoelectric properties of an N-type material based on rare earth (neodymium and gadolinium) selenide technology. Effort was expanded to experimentally describe the chemical, electrical and physical behavior of P-type thermoelectric material over a range of temperatures. Emphasis was changed in P-type material research from basic properties to sublimation suppression by wrapping, and to the understanding of contact resistance problems at the hot end. Analytical performance calculations were made as an aid in couple development. In the area of module development an evaluation of the reduction of bypass-heat loss was made and module M-22R was placed on test. Parts were fabricated for M23R. Data on long term operating characteristics, ingradient compatibility, and reliability of elements and couples was obtained.

THERMIONIC CONVERTERS

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 11575

12065 (COO—2263-15) **Advanced thermionic energy conversion. Joint highlights and status report, April-June 1979.** (Rasor Associates, Inc., Sunnyvale, CA (USA)). 1979. Contract EY-76-C-02-2263. 81p. (NSR—2-15). Dep. NTIS, PC A05/MF A01.

The DOE portion of the effort at Rasor Associates is directed primarily toward terrestrial applications of thermionic energy conversion. It focuses on the development of converters suitable for use with fossil fueled heat sources in power plants. The NASA program is directed at establishing the technical feasibility of an advanced light-weight long-life thermionic conversion system compatible with a remote nuclear or solar heat source. The principal application forseen at this time is in nuclear electric propulsion (NEP) missions in the mid-1990's. Significant accomplishments for the three month period include: (1) devised a blade-type distributed lead design with many advantages compared to the stud-type distributed lead; (2) completed design of Marchuk tube test apparatus; (3) concluded, based on current understanding, that residual hydrogen should not contribute to a negative space charge barrier at the collector; (4) modified THX design program to include series-coupled designs as well as inductively-coupled designs; (5) initiated work on the heat transfer technology, THX test module, output power transfer system, heat transfer system, and conceptual plant design tasks; and (6) reached 2200 hours of operation in JPL-5 cylindrical converter envelope test. (WHK)

12066 (COO—3056-42) **DOE/JPL Advanced Thermionic Technology Program. Progress report No. 40, July-August-September 1979.** (Thermo Electron Corp., Waltham, MA (USA)). 1979. Contract EY-76-C-02-3056. 115p. Dep. NTIS, PC A06/MF A01.

The primary long-term goal of the DOE effort at Thermo Electron Corporation is to improve TEC performance to the level that thermionic topping of fossil fuel steam powerplants becomes technically possible and economically attractive. The focus of the JPL program is to develop thermionic conversion technology appropriate for nuclear electric propulsion (NEP) missions. This report covers progress made during the three-month period from July through September 1979. During this period, significant accomplishments in the DOE program include: (1) Demonstration of 2300 hours of stable operation (Silicon Carbide Converter No. 1) in a combustion environment at emitter temperatures at, or above, 1600 K. This test is continuing. (2) Fabrication of two leaktight composite CVD (SiC/C/W) hot shell-emitter structures two inches in diameter. (3) Reproduction of W(100)/O/Zr emitter work function obtained at the Oregon Graduate Center. (4) Formation of an analytical model of the ignited mode thermionic diode which predicts the operating conditions associated with the onset of a double sheath at the emitter. Significant accomplishments in the JPL program include: (1) Demonstration of oxygen enhancement of a molybdenum emitter from a tungsten oxide collector. (2) Development of a technique for casting sapphire prototypic of NEP thermionic reactor system design. (3) Development of a technique for bonding lanthanum hexaboride to rhenium that was stable for 150 hours at temperatures ranging between 1600 and 1700 K. (4) Formulation of an assembly procedure for fabricating thermionic converters on an emitter heat pipe. (WHK)

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 12066

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 12066

FUEL CELLS

MATERIALS, COMPONENTS, AND AUXILIARIES

12067 (COO—2564-5) **Basic research on ceramic materials for energy storage and conversion systems. Progress report, December 1, 1978-November 30, 1979.** Whitmore, D.H. (Northwestern Univ., Evanston, IL (USA)). Dec 1979. Contract EY-76-S-02-2564. 55p. Dep. NTIS, PC A04/MF A01.

The present research program involves utilizing appropriate experimental probes for measuring the movement of ionic and electronic charge carriers in ceramic materials suitable for solid electrolyte and electrode applications in high-performance, secondary battery and fuel cell systems. Special emphasis is placed on developing: (1) a better understanding of the effects of structure, impurities and composition on charge carrier transport mechanisms in such materials; and (2) detailed knowledge of the kinetics and mechanism of reactions occurring (on a microscopic scale) at the electrode-electrolyte interfaces of energy storage and conversion systems.

ELECTROMECHANICAL CONVERTERS

REFER ALSO TO CITATION(S) 12055

12068 Maxwellian concepts of magnetro-electrodynamics and the reality of MED energy producing devices. Day, T. (Sam D. Ellis, Inc., Fulton, MO). pp 54-56 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978). From 5. conference on energy; Rolla, MO, USA (Oct 1978).

A brief history and the possibilities of magnetroelectrodynamic energy conversion are discussed. Magnetroelectrodynamics is defined as the direct conversion of magnetic energy to electric energy without the thermal interface. (WHK)

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 12016, 12017, 12018, 12019

12069 **Fifth annual UMR-DNR conference on energy.** Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978). 735p. (CONF-781042—).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

A separate abstract was prepared for each of the individual papers presented at the conference. (RCK)

BUILDINGS

REFER ALSO TO CITATION(S) 12011, 12012, 12013, 12543

12070 (BNL—50903) **Annual fuel usage charts for oil-fired boilers.** Berlad, A.L.; Yeh, Y.J.; Salzano, F.J.; Hoppe, R.J.; Batey, J. (Brookhaven National Lab., Upton, NY (USA); State Univ. of New York, Stony Brook (USA)). Jul 1978. Contract EY-76-C-02-0016. 141p. Dep. NTIS, PC A07/MF A01.

On the basis of laboratory-determined boiler efficiency data, one may calculate the annual fuel usage (AFU) for any oil-fired boiler, serving a structure of a given design heat load, for any specified hourly weather pattern. Further, where data are available regarding the energy recapture rates of the strucutre due to direct gain solar energy (windows), lighting, cooking, electrical appliances, metabolic processes, etc., the annual fuel usage savings due to such (re) capture are straightforwardly determinable. Employing the Brookhaven National Laboratory annual fuel usage formulation, along with efficiency data determined in the BNL Boiler Laboratory, computer-drawn annual fuel usage charts can be generated for any selected boiler for a wide range of operating conditions. For two selected boilers operating in any one of the hour-by-hour weather patterns which characterize each of six cities over a wide range of firing rates, domestic hot water consumption rates, design heat loads, and energy (re) capture rates, annual fuel usages are determined and graphically presented. Figures 1 to 98, inclusive, relate to installations for which energy recapture rates are taken to be zero. Figures 97 to 130, inclusive, apply to a range of cases for which energy recapture rates are nonzero and determinable. In all cases, simple, direct and reliable annual fuel usage values can be determined by use of charts and methods such as those illustrated.

12071 (BNL—51100) **Encapsulation of phase change materials in concrete masonry construction. Progress report No. 3, June 1978-September 1978. Final report.** Sansone, M.J. (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 25p. Dep. NTIS, PC A02/MF A01.

Work performed at Brookhaven National Laboratory on Union Carbide Nuclear Division, ORNL contract number 19Y-14279V, Encapsulation of Phase Change Materials (PCM) in Concrete Masonry Construction, is summarized. Due to program termination, the report also constitutes the final report of the program. Thermal analysis of the system $Na_2CO_3.10H_2O$ has shown that after separation upon melting, the heat of fusion is considerably higher than $Na_2SO_4.10H_2O$. The system $NaCO_3$-K_2CO_3-H_2O has been found to be unsuitable for PCM use. A eutectic in the $MgCl_2$-$CaCl_2$-H_2O is under consideration. It exhibits a high heat of fusion and low transition temperature range. Cylindrical shells have been cast using polymer concrete. The shells were subsequently filled with PCM and thermally cycled. No leaking of PCM occurred. Thermal measurements on PCM composite materials were continued.

12072 (CONF-791022—12) **Long-term ice storage for cooling applications using passive freezing techniques.** Gorski, A.; Schertz, W.; Rush, R.; Wantroba, A.; Cole, R. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 6p. Dep. NTIS, PC A02/MF A01.

From 4. national passive solar energy conference; Kansas City, KS, USA (3 Oct 1979).

The objective of this project is to develop a cost-effective method of solar cooling using natural ice formation in the winter to provide year-round cooling needs. A concept of natural ice formation that freezes the ice where it will be stored by means of passive refrigeration devices (modified heat pipes) is described. The project is composed of three phases, an initial experimental phase, construction and testing of a prototype device, and interactions with potential users and manufacturers. Preliminary results of this study are presented.

12073 (DOE/CS—0115) **Weighting factors. Technical support document for notice of proposed rulemaking on energy performance standards for new buildings.** (Department of Energy, Washington, DC (USA)). Nov 1979. 23p. Dep. NTIS, PC A02/MF A01.

It is DOE's decision that both Design Energy Consumption and Design Energy Budget be calculated as weighted sums of the quantities of the various fuel components of the building design energy requirements. Three alternatives have been suggested for determining the weights: (1) the use of Energy Budget Levels expressed in terms of the energy content of the fuel delivered to the building site, with all weights set equal to one (equivalent to veiwing design energy from the perspective of the building boundary); (2) the use of Resource Utilization Factors (RUF's) and Resource Impact Factors (RIF's) to reflect, respectively, the energy consumption to the Nation of providing energy to a building site, starting at the energy source, and the social impacts of using different fuel types; and (3) weighting factors based on the relative value of the different fuels to the Nation, expressed in terms of (1) fuel prices, and (2) explicit national policy determinations of nonmarket values associated with specific fuel types. The document explores the issues, advantages and disadvantages associated with each alternative. Further, it explains DOE's decision and choice of weighting factors. The different weighting options are considered in terms of impact on total US energy consumption, thermodynamic efficiencies, market prices, the nonmarket or social costs of various fuels, and the relative values of different fuels to the Nation. (TFD)

12074 (DOE/CS—0121) **Proposed energy performance standards for new buildings: draft regulatory analysis. Technical support document.** (Department of Energy, Washington, DC (USA). Office of Conservation and Solar Applications). Nov 1979. 59p. Dep. NTIS, PC A04/MF A01.

DOE's proposed energy-performance standards for new buildings have been developed in accordance with the Energy Conservation Standards for New Buildings Act of 1976 (Title III of P.L. 94-385, 42 U.S.C. 6831 et seq.) and Secton 304 of the DOE Organization Act, P.L. 95-91, 91 Stat. 965 et seq., 42 U.S.C. 7101 et seq. The Regulatory Analysis for the proposed standards discusses major alternatives to the regulation, examines the economic and administrative effects of each alternative, and explains why one alternative was selected over the others. The standards, which affect new buildings only, will require those buildings to be designed for greater energy efficiency than their present-day counterparts. The standards will not regulate the actual energy consumption of the building once constructed and in use. In the long term, the presence of these energy-efficient buildings will reduce the amount of additional nonrenewable energy that the nation will need. In the short term, these more-efficient buildings will reduce the impact of rising energy costs on new-building owners.

12075 (DOE/CS—0122) **Proposed energy performance standards for new buildings: statistical analysis. Technical support document.** (Department of Energy, Washington, DC (USA). Office of Conservation and Solar Applications). Nov 1979. 504p. Dep. NTIS, PC A22/MF A01.

This document describes the statistical procedures used by DOE as a basis for the proposed energy budget levels for commercial and multifamily residential buildings. It provides DOE with a reliable basis from which to select Energy Budget Levels and provides DOE with a reliable basis from which to identify specific Energy Budget Levels. Much of the research was conducted by AIA Research Corporation in support of the Energy Budget Level selection process.

12076 (LUTVDH/(TVBH—1001)/1-315/(1979)) **Internal additional insulation: thermal bridges, moisture problems, movements and durability.** Andersson, A.C. (Tekniska Hoegskolan, Lund (Sweden). Inst. foer Byggnadsteknik). 1979. 318p. (In Swedish). Dep. NTIS (US Sales Only), PC A14/MF A01.

The report deals with the problems which may be caused by internal additional insulation of an existing building component. Problems treated in this report are heat losses through and surface condensation at thermal bridges, condensation in the building components, stresses due to temperature and moisture content variations and possibly frost damage in facade materials. After internal insulation, thermal bridges such as joist connections, inner wall connections and window splays have an increased effect on heat losses through an outer wall. Computer calculations have been made to estimate this effect. Thermal bridges also reduce surface temperatures in a room. This in some cases increases the risk for surface condensation. The effect is, however, relatively small. Condensation in a building component is likely to occur if the internal insulation is made without a new vapor barrier. The condensation risk is naturally greatly influenced by the climatic conditions and the moisture capacity of the building materials. One-dimensional nonstationary calculations of the temperature and moisture field in some building components before and after additional insulation have been made with a computer program. Laboratory investigations of thermal and moisture conditions in two types of walls after thermal insulation have been made.

12077 (NP—24053) **Summary of regulations on energy conservation: text analysis, financial assistance, and specialized organizations.** (Institut Francais de l'Energie, 75 - Paris). 1 Jan 1979. 174p. (In French). Dep. NTIS (US Sales Only), PC A08/MF A01.

This document consists primarily of four sections: (1) outline of texts of the most important regulations on utilization and conservation of energy - classified as a function of application; (2) references to other regulations related to energy utilization; (3) principal characteristics of financing aids available to industry for financing

investments in energy conservation, including new processes and techniques; and (4) public and other organizations charged with the formulation and implementation of energy policy. Also, a final section gives three brief examples of application of the regulations.

12078 (NTIS/PS—79/0461) **Thermal insulation for buildings (citations from the Engineering Index data base). Report for 1970-March 1979.** Habercom, G.E. Jr. (National Technical Information Service, Springfield, VA (USA)). May 1979. 201p. NTIS PCN01/MF N01.

Materials and methods for thermal insulation of buildings are investigated in these reports gathered in a worldwide literature survey. Residential buildings, farm structures, and factories are researched for insulation effectiveness and optimization. (This updated bibliography contains 195 abstracts, 34 of which are new entries to the previous edition.)

12079 (PNL-SA—7073) **Net economic impacts of conservation programs in the building sector.** Foley, T.J.; Deonigi, D.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1978. Contract EY-76-C-06-1830. 13p. (CONF-780755—3). Dep. NTIS, PC A02/MF A01.

From Engineering foundation conference; Henniker, NH, USA (27 Jul 1978).

Research measuring net impacts of specific conservation programs on affected groups is investigated. Impacts on energy use, employment, investment and trade, with special emphasis on energy use and employment are measured. Programs analyzed include the proposed National Energy Plan, recent Federal legislation, and other private research programs aimed at accelerating the market penetration of energy efficient appliances (Appendix). The results displayed are the product of the integrated analytical capabilities of ORNL, BNL, and Battelle, PNL.

12080 **Tagung ueber waermepumpen - forschung, entwicklung und anwendung. (Meeting on heat pumps research, development and application).** Ehringer, H.; Hoyaux, G. (eds.). Luxembourg, Belgium; Commission of the European Communities (1979). 380p. (In several languages). (EUR—6237; CONF-7809190—). European Community Information Service, Washington, DC.

From Meeting on heat pumps research, development and application; Brussels, Belgium (27 Sep 1978).

Twenty-one papers were presented at the meeting. A separate abstract was prepared for each paper. (LCL)

12081 **Stratiform domes: high performance thin-shell concrete structures.** Zimmerman, J.P. (Stratidome Corp., Boulder, CO). pp 244-253 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

The stratiform method of dome construction was invented in response to the need for energy conserving space enclosures. Polyurethane foam and concrete are spray applied in sequential layers on the inside of a balloon air-form. This process results in structures which require approximately one-tenth of the building materials with which to build them, and one-third of the energy with which to heat or cool them.

12082 **To light or not to light: that is the energy question.** Nelson, J.B.; Hegler, B.E. (Univ. of Missouri, Rolla). pp 446-450 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

The controversy over lighting levels has existed for some time. Interest in methods of lighting has been heightened by the energy crisis. It has been estimated that lighting consumes approximately five percent of the nation's energy, therefore lighting is a relatively small energy user when compared to transportation and industrial processes which consume the bulk of the nation's energy. However, any saving that will make a contribution to the energy crisis should be considered. Consequently, this paper shows how energy for lighting may be reduced without sacrificing the present quality of lighting and in some cases, actually improve the lighting quality.

RESIDENTIAL BUILDINGS

REFER ALSO TO CITATION(S) 12050, 12137

12083 (CONF-781108—, pp 126-145) **Use of semi-controlled experiments in the analysis of residential energy demand.** Mayer, L.S. (Princeton Univ., NJ). Jul 1979.

From 4. DOE statistical symposium; Albuquerque, NM, USA (1 Nov 1978).

The experiences of statisticians on the Twin Rivers energy research program are reviewed. The general advantages of using experimental programs in research on residential energy usage are considered along with the limitations of competing analytic approaches. It is argued that research in this area and other policy relevant energy areas would benefit greatly from wider funding of large-scale experimental programs and that statisticians could play a key role in the design, execution and analysis of the experiments. Reasons for the rarity of large-scale statistical experimental research programs which analyze residential energy demand are considered. The major roles that statisticians played on the Twin Rivers program are discussed and some of the results obtained, in part, by the statisticians on the project are reviewed.

12084 (DOE/CS—0119) **Proposed energy performance standards for new buildings: energy budget levels selection. Technical support document.** (Department of Energy, Washington, DC (USA). Office of Conservation and Solar Applications). Nov 1979. 102p. Dep. NTIS, PC A06/MF A01.

This document sets forth the data and procedures used by DOE to select proposed energy budget levels. Of three broad categories of new buildings (commercial, residential, and mobile homes), DOE determined that sufficient information existed upon which to select energy budget levels for single-family residential, and commercial and multifamily residential buildings. Because of analytical difficulties in separating process energy requirements from space-conditioning energy requirements, no energy budget levels are proposed for industrial buildings or restaurants. Also, inconclusive analyses resulted in no energy budget levels being proposed for mobile homes. DOE conducted extensive analyses of the design energy requirements of buildings, utilizing a variety of approaches. One approach was to conduct architectural studies of samples of commercial, residential, and mobile-home designs. Simulation studies were conducted to analyze the design energy requirements of prototypical single-family residential buildings. A separate life-cycle cost study of office buildings was done. Economic studies were conducted to assess the impact of different assumed levels of the standards on building owners, elements of the construction industry, and the nation as a whole. This document explains the energy budget levels selection process and the data upon which DOE relied.

12085 (DOE/EIA—0207/1) **Single-family households: fuel oil inventories and expenditures. National Interim Energy Consumption Survey.** (Department of Energy, Washington, DC (USA). Office of Consumption Data System). Dec 1979. 24p. Dep. NTIS, PC A02/MF A01.

This report presents the results of the Energy Information Administration's (EIA) quick-response survey of fuel oil use by single-family households. Two surveys were conducted in August and September 1979 to determine if households were experiencing problems in obtaining fuel oil. The surveys also collected information on the households' expenditures for fuel oil and their conservation activities. 12 tables.

12086 (NTIS/PS—79/0460) **Thermal insulation for residential homes (citations from the NTIS data base). Report for 1964-April 1979.** Habercom, G.E. Jr. (National Technical Information Service, Springfield, VA (USA)). May 1979. 151p. NTIS PCN01/MF N01.

Materials and installation methods for thermal control of residential buildings are investigated in these Federally-funded research reports. The thermal efficiency of window glass, cellular materials, glass wool, fibers, wood, and other insulating materials is reviewed. (This updated bibliography contains 143 abstracts, 43 of which are new entries to the previous edition.)

12087 (ORNL/SUB—7226/1) **Research and development of an air-cycle heat-pump water heater. Final report.** Dieckmann, J.T.; Erickson, A.J.; Harvey, A.C.; Toscano, W.M. (Foster-Miller Associates, Inc., Waltham, MA (USA)). 1 Oct 1979. Contract W-7405-ENG-26. 343p. Dep. NTIS, PC A15/MF A01.

A prototype reverse Brayton air cycle heat pump water heater has been designed and built for residential applications. The system consists of a compressor/expander, an air-water heat exchanger, an electric motor, a water circulation pump, a thermostat, and fluid management controls. The prototype development program consisted of a market analysis, design study, and development testing. A potential residential market for the new high-efficiency water heater of approximately 480,000 units/y was identified. The retail and installation cost of this water heater is estimated to be between $500 and $600 which is approximately $300 more than a conventional electric water heater. The average payback per unit is less than 3-1/2 y and the average recurring energy cost savings after the payback period is approximately $105/y at the average seasonal coefficient of performance (COP) of 1.7. As part of the design effort, a thermodynamic parametric analysis was performed on the water heater system. It was determined that to obtain a coefficient of performance of 1.7, the isentropic efficiency of both the compressor and the expander must be at least 85%. The selected mechanical configuration is described. The water heater has a diameter of 25 in. and a height of 73 in. The results of the development testing of the prototype water heater system showed: the electrical motor maximum efficiency of 78%; the compressor isentropic efficiency is 95 to 119% and the volumetric efficiency is approximately 85%; the expander isentropic efficiency is approximately 58% and the volumetric efficiency is 92%; a significant heat transfer loss of approxi-

mately 16% occurred in the expander; and the prototype heat pump system COP is 1.26 which is less than the design goal of at least 1.7. Future development work is recommended.

12088 (ORO—5552-T7) **Improving the efficiency, safety, and utility of woodburning units. Quarterly report No. WB-6.** Maxwell, T.T.; Dyer, D.F.; Maples, G. (Auburn Univ., AL (USA). Dept. of Mechanical Engineering). 15 Mar 1979. Contract EC-77-S-05-5552. 127p. Dep. NTIS, PC A07/MF A01.

This report describes the work completed during the period December 15, 1978 to March 15, 1979. Work has continued on all phases of the project. Tests have been performed to determine the effects of wood type, wood piece spacing and baffling on the efficiency and heat output of woodburning stoves. The research team has assisted the Fireplace Institute in developing performance standards for use in a rating program for woodburning appliances. Comparative tests have been conducted to verify that the test methods described in these standards are accurate and repeatable, and hence, will provide the basis for a credible rating program. These standards have now been accepted by the industry and the rating program will get underway in late April or early May. One phase of this project is to study creosote, in particular, the parameters that influence the formation of creosote. Due to the intense interest by the industry, the creosote work has been extended to include experimental and analytical thermal analyses of flues and chimneys during a creosote fire. The research team continues to transmit results and information to the woodburning industry.

12089 (PB—290471) **Weatherization training: a notebook for weatherization. Supplement number 2. Basic supervision; cooperation with utilities and other energy suppliers; publicizing energy conservation and weatherization programs.** Gauthier, T.; Levy, A. (Syracuse Research Corp., NY (USA). Energy Research Center). Nov 1978. 38p. NTIS, PC A03/MF A01.

A series of bulltins are presented to provide technical assistance to administrators of programs to weatherize the homes of poor persons. Topics in this supplement are supervision of weatherization crews, cooperating with utilities and other energy suppliers, and publicizing energy conservation programs.

12090 (PB—290528) **Determinants of residential electrical appliance usage in the Tri-State Region, 1960-1970: a regression study. Working paper.** Stone, B. (New York Regional Energy Study, NY (USA)). May 1974. 51p. NTIS, PC A04/MF A01.

The possible impact of areawide residential location policy on future residential electricity usage in the Tri-State Metropolitan Region centering on New York City is investigated. This study was undertaken to assess residential electricity usage, particularly electrical appliance use, in the residential sector of the New York Metropolitan area from 1960 to 1970. The attempts to choose and quantify the contribution of various determinants of electrical appliance usage using multiple regression analyses has been relatively successful. In addition, these results were compared with 1960 and 1970 data in an effort to establish a degree of consistency over time. The implications of the findings here point toward two complementary institutions for change: urban planning and public administration. The relationship between single family structures and high energy usage argue strongly for more dense communities, while price elasticities can be used by regulators to control electrical usage.

12091 (PB—290531) **Electric household equipment and electric fuel usage in the Tri-State Region and the United States: 1960-70. Working paper.** Hillman, B. (New York Regional Energy Study, NY (USA)). Aug 1973. 17p. NTIS, PC A02/MF A01.

The possible impact of areawide residential location policy on future residential electricity usage in the Tri-State Metropolitan Region centering on New York City is investigated. This report is concerned with selected residential electric appliance usage in the Tri-State Region as compared with usage of these appliances across the United States between 1960 and 1970. Included are tabular representations of comparisons between residential air conditioner usage in the Tri-State Region and the United States. Tabular comparisons also are made with respect to residential appliance usage and electric fuel usage.

12092 (PB—290843) **Preliminary forecast of 1985 residential electricity consumption in the Tri-State Region. Working paper.** Hansen, W.B. (New York Regional Energy Study, NY (USA)). Dec 1973. 55p. NTIS, PC A04/MF A01.

The possible impact of areawide residential location policy on future residential electricity usage in the Tri-State Metropolitan Region centering on New York City is investigated. This paper reports on a preliminary forecast of 1985 electric energy consumption by the New York Region's households. The forecast derives from currently accepted residential development plans and projections of the Tri-State Regional Planning Commission. It yields a 'most likely' 1985 aggregate regional household consumption figure of nearly 56,000 megawatt hours--i.e., a 109 percent increase over the approximately 27,000 mgh used during 1970.

12093 (PB—293498) **CSA Weatherization Demonstration Project Plan.** Crenshaw, R.; Clark, R.; Chapman, R.; Grot, R.; Godette, M. (National Bureau of Standards, Washington, DC (USA). Center for Building Technology). Mar 1979. 81p. NTIS PC A05/MF A01.

This report comprises the plan of a research and demonstration effort to determine the fraction of energy that may be saved by installing weatherization retrofits in poor peoples' homes throughout the United States. Two broad groups of weatherization retrofits are considered for application in each dwelling: (1) 'architectural,' those affecting the building shell; and (2) 'mechanical,' those affecting space heating and service hot water systems. The report presents the background of the demonstration, the research tasks associated with the demonstration, a description of the diagnostic tests to be used, the rationale for economic decisions, the tests for evaluating mechanical systems, and the calculation methods used in selecting architectural options.

12094 (PB—294305) **The Stockton Training Center: an experiment in weatherization program training.** Kinney, L.F.; Jurnak, J.; Klein, G. (Syracuse Research Corp., NY (USA). Energy Research Center). Feb 1979. 45p. NTIS, PC A03/MF A01.

The report describes a program in California that provides training to crews involved in the weatherization of homes of low-income people. The Stockton Training Facility, operated by the Pacific Gas and Electric Company (PGandE), is the result of a cooperative effort of the California-Nevada Association of Community Action Agencies, PGandE, the Community Services Administration and the California State Office of Economic Opportunity. Details are given for the design of the training facility, costs and curriculum.

12095 (SAND—79-2110) **Selected residential electric rates and rate structures in the US.** Caskey, D.L. (Sandia Labs., Albuquerque, NM (USA)). Jan 1980. Contract EY-76-C-04-0789. 37p. Dep. NTIS, PC A03/MF A01.

Residential electric rate structures, including fuel adjustments and other charges, for 16 US cities were surveyed in July, 1979. Total bills for usages of 1000 kWh and 2000 kWh per month were determined. The average rate of increase in rates over the past three years was found to be 15% per year, compared to the general inflation rate of just over 7% per year for the same period. Present and proposed utility rates for time-of-day pricing and buyback are included.

OFFICE BUILDINGS

12096 (LBL—8913) **Storage of heat and coolth in hollow-core concrete slabs. Swedish experience, and application to large, American-style buildings.** Anderson, L.O.; Bernander, K.G.; Isfaelt, E.; Rosenfeld, A.H. (RLI Byggdata AB, Saltsjobaeden (Sweden); AB Strangbetong, Stockholm (Sweden); Kungliga Tekniska Hoegskolan, Stockholm (Sweden); California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 26 Oct 1979. Contract W-7405-ENG-48. 28p. (CONF-791009—25). Dep. NTIS, PC A03/MF A01.

From International conference on energy use management; Los Angeles, CA, USA (22 Oct 1979).

The Folksam office building in Farsta, near Stockholm, has operated since December 1977 with an energy use for direct space heating of only 60 kWh/m^2 [19,000 Btu/ft^2], which is only half the Stockholm average for new buildings. To this 60 kWh/m^2 must be added the typical electric use of another 60 kWh/m^2 for lights, equipment, fans, etc. Even though Stockholm has 3580 deg-day (C), new Swedish buildings are so well insulated that their temperature floats upwards during most winter working days. In the Folksam building, this surplus heat from 40 full-occupied hours per week is stored in hollow-core concrete slabs, and then is used to compensate for the heat losses during the remaining 128 unoccupied hours. The energy transport/storage system necessary to keep the indoor temperature comfortable, summer and winter, is called Thermodeck, and is described in detail.

SCHOOL, MUNICIPAL AND OTHER PUBLIC BUILDINGS

12097 (AD-A—068599) **Survey of energy utilization and conservation efforts at military dining facilities. Technical report.** Hu, K.H.; Lampi, R.A.; Nibi, J.P.; Lord, E.R. (Army Natick Research and Development Command, MA (USA). Food Engineering Lab.). Apr 1978. 120p. NTIS, PC A06/MF A01.

The report presents the results of a questionnaire survey of 111 military installations consisting of 720 dining facilities in energy utilization and local efforts in energy conservation. Ovens as a group have been identified as the highest energy consuming item as compared with other major cooking equipment. Exhaust hoods have been identified as one of the longest operating items. As a result of energy shortages, local adaptive efforts in energy conservation are in practice in some military installations. There is no systematic in-depth program to bring about an achievable goal in maximum energy conservation. However, with the energy utilization informa-

tion available from the survey, plus measures on energy conservation in food service operation available in publications, possible cost savings resulting from recommended conservation steps are enumerated. These conservation steps not only can save energy, but will also greatly reduce equipment breakdown as a result of not leaving equipment in idling condition more than necessary.

12098 (LBL—9356) **Hospital energy audits: a bibliography.** Pollack, R.I.; Boe, J.; Roseme, G.D.; Chatigny, M.A.; Devincenzi, D.D. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1979. Contract W-7405-ENG-48. 76p. (EEB-Hosp—79-3). Dep. NTIS, PC A05/MF A01.

Data collected in an energy audit may be used to rank energy-conservation opportunities, usually with the goal of reducing energy consumption in a cost-effective manner. This bibliography with abstracts of about 100 items on hospital energy audits is divided into three parts: accounts of hospital energy audits; instructional material on hospital energy audits including manuals, workbooks, instructional articles, etc.; and miscellaneous documents. (MCW)

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 12084

12099 (PB—290842) **Demand for electricity by the commercial sector of the New York Region: analysis and projections for 1985. Working paper.** Drennan, M.; Tobier, E. (New York Regional Energy Study, NY (USA)). Feb 1975. 50p. NTIS, PC A03/MF A01.

The commercial sector of the New York Region is compared with the national commercial sector in terms of relative size, growth, and growth of component industries. Ordinary least squares equations were estimated for the region, relating commercial sector electricity consumption to measures of the sector's size (employment and payrolls), productivity, and electricity prices. Cross-section equations were estimated for 1970, using 23 counties in the region. Time-series equations were estimated for the 1959-72 period. Projections of commercial sector electricity consumption were calculated for 1985 (using estimated equations) under three assumptions about the 1970-85 trend in real electricity prices. Even the highest consumption projection shows a marked slowing in electricity consumption growth compared with the past.

12100 (PB—290853) **Progress report on projections of demand for electric energy for manufacturing in 1985. Working paper.** Drennan, M. (New York Regional Energy Study, NY (USA)). 25 Oct 1973. 13p. NTIS, PC A02/MF A01.

The possible impact of areawide residential location policy on future residential electricity usage in the Tri-State Metropolitan Region centering on New York City is investigated. This memorandum reports on the progress of the projections of demand for electric energy for manufacturing in 1985. The projection procedure is represented algebraically. The output of this procedure is 437 value added estimates for 1985 (19 industries x 23 counties). A number of cross section multiple regression equations have been estimated for the year 1971 using all manufacturing data by county. The dependent variables are electricity consumption and value added of all manufacturing industries by county.

12101 (PB—290906) **Consumption of electric energy by manufacturing industries in the New York Region. Working paper.** Arney, D.E. (New York Regional Energy Study, NY (USA)). Aug 1973. 87p. NTIS, PC A05/MF A01.

The use of electrical energy in the manufacturing sector of the New York Metropolitan Region is discussed. The report presents data showing electricity consumption by SIC group for each regional county for selected years between 1950 and 1970. It delves into the use of electricity in the manufacturing process, and investigates some of the forces which affect the magnitude of consumed electricity. Regional patterns are analyzed.

12102 (PB—290970) **Electricity consumption in manufacturing in the New York Region. Working paper.** Ruppert, C.A. (New York Regional Energy Study, NY (USA)). Feb 1974. 18p. NTIS, PC A02/MF A01.

The possible impact of areawide residential location policy on future residential electricity usage in the Tri-State Metropolitan Region centering on New York City is investigated. Factors affecting electricity consumption within various manufacturing industries are studied. Equations are developed which relate electricity consumption as a function of value added to wage rates and other inputs to the manufacturing process.

12103 (PB—292006) **Econometric analysis of electricity and natural gas consumption by two-digit manufacturing industries in the New York Region. Working paper.** Menchin, M. (New York Regional Energy Study, NY (USA)). Jan 1974. 20p. NTIS, PC A02/MF A01.

Emphasis is on deriving econometric models, using a simultaneous equation system, for determining electricity and natural gas demand in the manufacturing sector of the New York Region. Cross-sectional regressions are derived for each SIC group for the New York metropolitan area as a whole.

12104 (PB—292012) **Economic data for projections of unconstrained demand for electric energy for manufacturing, 1985. Working paper.** Netzer, D. (New York Regional Energy Study, NY (USA)). Aug 1973. 8p. NTIS, PC A02/MF A01.

The possible impact of areawide residential location policy on future residential electricity usage in the Tri-State Metropolitan Region Centering on New York City is investigated. This report outlines procedures for projecting value added by two-digit manufacturing industry and by county, to 1985. Regression equations developed on the basis of historical data (through 1970) are applied to projections of the independent variables to 1985. The principal economic variables are the price of electric power and value added by manufacturing in constant dollars by two-digit industry, for each of the 23 counties in the region. The substantive economic activity projection is that of employment by two-digit industry by county.

TRANSPORTATION

REFER ALSO TO CITATION(S) 12077

12105 (PB—290517) **Current transportation issues in the United States. Volume II. Issues papers and source materials.** (National Transportation Policy Study Commission, Washington, DC (USA)). Sep 1978. 375p. NTIS, PC A16/MF A01.

The report discusses 25 major issues in transportation. Issues were derived from the Commission's literature review, survey, and public hearings. Volume I briefly summarizes the issue identification process and the issues. Volume II provides a detailed review of past transportation studies, a summary of survey and hearing results, and a discussion of the background and importance of each issue. The issues discussed affect many areas of transportation including government regulation, jurisdiction, planning, finance, energy, environment, labor, safety and equity.

12106 **Opportunities in Canadian transportation.** Ottawa, Ontario; Minister of Supply and Services (1979). 162p. (CONF-7905121—). Science Council of Canada, 100 Metcalfe St., Ottawa, Ontario.

From Intercity passenger transport conference; Ottawa, Canada (17 May 1979).

The proceedings of a two-day conference on the growth, economics, and energy aspects of intercity passenger transport by automobile, bus, aircraft and railways in Canada are presented. (LCL)

LAND AND ROADWAY

REFER ALSO TO CITATION(S) 11176, 12157

12107 (PB—290493) **Transportation and land development: conference proceedings. Final report.** Hand, I.; Vumbaco, B.J. (Environmental Protection Agency, Seattle, WA (USA). Surveillance and Analysis Div.). 1978. 57p. NTIS, PC A04/MF A01.

The conference had 'strategic transportation investments to achieve regional development objectives' as its central theme. Concepts that kept recurring and that are highlighted in the report's conclusions were the need to conserve energy, to improve the environment and the quality of life, and to revitalize cities. Although several speakers referred to the role of transportation in the economic and social revival of downtown areas, all recognized that development does not necessarily accompany transportation improvement. The Agenda consisted of suggested policy, programs, and research to deal with urban revitalization, energy conservation, economic development, and quality of life. For example, the conferees called for a national transportation policy that supports cities as places to live as well as work - a recognition that such revitalization is the most critical economic objective facing the nation today.

12108 (PB—290666) **Restorative maintenance retesting of 1977 model year passenger cars in Denver. Technical report.** Jones, G.T. (Environmental Protection Agency, Ann Arbor, MI (USA)). Nov 1978. 36p. NTIS, PC A03/MF A01.

The report describes the results of an exhaust emission testing program in which 24 relatively new vehicles sampled in a Restorative Maintenance Program in Denver were retested approximately one year later. Many vehicles had experienced maladjustments and disablements even though the owner reported that he felt his vehicle had been maintained according to the manufacturer's recommendations. Reductions in average emission levels followed the correction of the maladjustment and disablement actions to a point close to those after the prior tune-up. Modest fuel economy improvements were noted this year, probably due to the fact that the vehicles had overcome the 'green engine' effect.

12109 (PB—290969) **Light duty vehicle driveability investigation.** Toulmin, H.A. Jr. (Suntech, Inc., Marcus Hook, PA (USA)). Dec 1978. Contract EPA-68-03-2607. 435p. NTIS, PC A19/MF A01.

This report describes the results of an automobile driveability, emission, fuel economy and performance testing program conducted for the U.S. Environmental Protection Agency. A total of twenty-two 1977 and 1978 model vehicles were subjected to a series of tests when adjusted to the manufacturers' recommended settings and when adjusted to simulate maladjustments found on in-use vehicles in an earlier EPA Restorative Maintenance Evaluation Project. The CRC driveability tests were performed on a weather controlled large roll chassis dynamometer at 16C and the emissions and fuel economy tests were conducted according to the 1975 Federal Test Procedure, except that evaporative emissions tests were not conducted.

12110 (PB—293645) **Technology assessment of changes in the future use and characteristics of the automobile transportation system. summary and findings.** (Office of Technology Assessment (U.S. Congress), Washington, DC). Feb 1979. 48p. NTIS, PC A03/MF A01.

The assessment deals with changes in the future use and characteristics of the automobile transportation system that are expected in the near term (by 1985) and those that might evolve over a longer period (through 2000 and beyond). The scope of the assessment is broad and includes not only automobiles but also highways, fuel supply and distribution, automotive repair and service, insurance, traffic management, and law enforcement--in short, all of the industries and services that contribute to use of the automobile as a mode of personal transportation. The report analyzes the restraints of energy supply, environmental impacts, highway safety, and consumer cost on the further development of the automobile transportation system. It discusses Government initiatives that may be necessary to assure such further development. Detailed projections, policy analyses, and technological forecasts incorporated in this volume are published in Volume II--Technical Report.

12111 (PB—293646) **Technology assessment of changes in the future use and characteristics of the automobile transportation system. Volume II: technical report.** (Office of Technology Assessment (U.S. Congress), Washington, DC). Feb 1979. 385p. NTIS, PC A17/MF A01.

The report consists of three parts. The first part contains background information, a description of the elements of the automobile transportation system, Base Case projections, and delineation of the policy alternatives that were considered. These chapters provide a baseline of present and future automobile system characteristics that serve as the frame of reference for policy analysis. The second part of the report contains analyses of policy options in each of the five issue areas--energy, environment, safety, mobility, and cost and capital. Each chapter is similarly organized and contains a discussion of issues, a summary of present policy, a statement of policy options, and analysis of effects and impacts. The third part of the report is a survey of expected technological developments in the near term (through 1985) and in the far term (to 2000 and beyond). A summary of major findings and a detailed table of contents is included in each chapter.

SEA AND WATER

REFER ALSO TO CITATION(S) 12122

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 11414, 11415, 11420, 11579, 12077

12112 **Conducting successful energy audits.** Phillips, J.M.; Turner, W.C.; Webb, R.E. (Oklahoma State Univ., Stillwater). pp 430-435 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

Part of any successful energy management program is well designed and conducted energy audits. Basically, there are three types of energy audits. They are: (1) gross, (2) detailed, and (3) walk-through survey. Unfortunately, the literature seldom distinguishes between the three resulting in some confusion. This paper helps clear that confusion by defining each type, giving examples of their application, and presenting directions or guidelines. Forms for each type of audit are included with the examples. The forms and instructions have been developed under a program at Oklahoma State University designed to research and disseminate information to help industry better weather the energy crisis and have been tested in actual industrial situations.

EQUIPMENT AND PROCESSES

REFER ALSO TO CITATION(S) 11223, 11263, 11264, 11265

12113 (BNL—51080) **Polyketones and polysulfones for conservation in the ethylene polymer industry. Progress report No. 5, April-June 1979.** (Brookhaven National Lab., Upton, NY (USA); Tenneco Chemicals, Inc., Piscataway, NJ (USA)). Aug 1979. Contract EY-76-C-02-0016. 23p. Dep. NTIS, PC A02/MF A01.

Reaction kinetic studies were continued on the ^{60}Co gamma-induced polymerization of ethylene-SO_2 (Et-SO_2) mixtures. A peak in reactivity, as measured by an overall G-value of 8.4 x 10^4 molecules/100 eV, was found at 1.9 mole % SO_2 for gas-phase mixtures containing up to 6.7 mole % SO_2 and over a pressure range of 22.3 to 56.1 atm. Overall rates and G-values were obtained for liquid-phase SO_2 saturated with ethylene at up to 58.2 atm total pressure. A maximum G-value of 1.3 x 10^5 molecules/100 eV was found in the pressure range of 34.0 to 58.2 atm. Inert gases such as helium and nitrogen in Et-SO_2 gas mixtures were found to reduce peak G-values by an amount greater than could be accounted for on the basis of dilution alone. The additional effect is believed to be due to buildup of an inert gas diffusion barrier at the polymerization sites. The ^{60}Co gamma-induced polymerization of propylene-SO_2 mixtures was investigated briefly. For the gas-phase system containing 0 to 50 mole % SO_2 in the 1 to 5 atm range, a maximum rate was found at equimolar gas composition. No other peak was found at a lower SO_2 concentration. The data indicate a power of 3 dependence of the rate on pressure and a power of 2 dependence of the G-value on pressure. A G-value of 1.38 x 10^8 molecules/100 eV was obtained for liquid SO_2 saturated with propylene at 6.24 atm. Both gas-phase and liquid-phase product analyzed approximately 1:1 molar ratio propylene/SO_2.

12114 (COO—4527-3) **Application of foams to the processing of fabrics. Interim report, October 1, 1977-March 31, 1979.** Duke, M.W. (United Merchants Research Center, Langley, SC (USA)). Apr 1979. Contract EC-77-C-02-4527. 48p. Dep. NTIS, PC A03/MF A01.

The primary objective of this project is to reduce the energy requirements for finishing fabrics by drastically reducing the water required to wet process the fabrics. Since less water is used, less energy is consumed in the evaporation of water. This is accomplished by replacing much of the water with air, making a foam and using it as the application medium. In the first six months of the project the practicality of foam fabric finishing on a commercial basis had been established. Limited yardage of fabrics equivalent in performance to conventionally wet finished fabrics were processed. In these mill trials, a range of foam fabric finishes including softeners, hand builders, durable press and shrink-resistant types were applied to cotton sheeting, corduroy and polyester/cellulosic blends, etc. In all cases, substantial energy savings were realized. Since the issuance of the first and second interim reports, commercial practice of foam fabric finishing continues to grow with cumulative total estimated as approaching 200,000,000 yards. A number of companies are currently using foam fabric finishing as a commercial production process. Additionally, the pilot range has been used to demonstrate foam fabric finishing to over twenty companies. The range has been used to demonstrate the foam acid dyeing of nylon carpets to several companies in this specialized area of textile processing. Active work still continues with these companies since the foam dyeing of carpets involves only about 1/5 the water used in the normal continuous dyeing of carpets. At the time of writing two carpet companies are actively working to evaluate foam dyeing on a mill scale. (LCL)

12115 (COO—4881-13) **Energy savings by means of fuel cell electrodes in electro-chemical industries. Progress report, August 1, 1979-October 31, 1979.** Allen, R.J.; Juda, W.; Lindstrom, R.W. (Prototech Co., Newton Highlands, MA (USA)). 12 Dec 1979. Contract ET-78-C-02-4881. 18p. Dep. NTIS, PC A02/MF A01.

Initial efforts in studies of the effects of fuel cell electrodes on energy savings in electrochemical processes have been directed toward assembling test hardware and evaluation of a new zinc plant feed. A complete chemical analysis of the feed is reported. Utilizing the 2" x 2" (active electrode area) hardware and techniques developed under Contract No. ET-78-C-02-4881, 6 h zinc electrowinning tests demonstrated a current efficiency of greater than 90% with an energy consumption of 0.54 to 0.55 kWh/lb of zinc. For these tests, 0.1 g/l gelatin was employed as an electrolyte additive and the resultant zinc plates were bright, smooth and compact.

12116 (DOE/TIC—10216) **Energy cost reduction program for the printing industry.** (Federal Energy Administration, Washington, DC (USA); Printing Industries of America, Arlington, VA (USA)). 15 Jul 1977. 57p. Dep. NTIS, PC A04/MF A01.

This handbook presents help for commercial printers to cut the cost of energy in their business establishments. It shows how to recognize and act on energy waste in: interior and security lighting; space heating; air conditioning; process, and general plant mainte-

nance. The distribution of energy use varies widely among printing facilities, but certain conclusions can be drawn. Process energy, generally electricity, typically consumes 30 to 50% of total energy costs in the operation of presses and trimmers, compressed air generation, and production of binders. Lighting is a significant expense, and may consume up to 33% of energy expenses. Heating and air conditioning are seasonal and show the expected climatic variations - from 15 to 38%. Hot water generally represents 1 to 2% of total costs and is usually represented in heating costs.

12117 (NTIS/PS—79/0648) **Energy conservation: industry (a bibliography with abstracts). Report for 1964-May 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Jul 1979. 305p. NTIS PCN01/MF N01.

Potential methods of conserving energy, including fuel and materials substitutions, are considered for various industries. Many abstracts deal with reports that also cover processes used, amount of energy consumed, and environmental considerations of energy conserving options. Industries covered include food, paper, chemical, cement, metals, petroleum refining, contract construction, synthetic rubber, plastics, drug manufacturing, and stone, clay, and glass. Energy conservation through the use of waste heat is covered in a related Published Search entitled Waste Heat Utilization. The updated bibliography contains 298 abstracts, 74 of which are new entries to the previous edition.

12118 (PB—293344) **Energy requirements for New York State agriculture. Part 2: indirect energy inputs. Agricultural extension engineering bulletin.** Gunkel, W.W.; Price, D.R.; Lucas, G.M.; Murray, D.L.; Casler, G.L. (New York State Coll. of Agriculture and Life Sciences, Ithaca (USA)). 1976. 35p. NTIS PC A03/MF A01.

The objectives of this study were to: (1) determine the most important indirect energy inputs and requirements for agricultural production and processing in New York State, and (2) establish an index or model to use in projecting indirect energy requirements for agricultural production and processing systems.

12119 (PB—293859) **Wayside energy storage study. Volume III. Engineering economics analysis: data and results. Final report May 1977-June 1978.** Lawson, L.J.; Cook, L.M. (AiResearch Mfg. Co., Torrance, CA (USA)). Feb 1979. Contract DOT-TSC-1349. 570p. NTIS PC A24/MF A01.

Volume III contains the detail of the engineering economics analysis which showed attractive returns on investment for deployment of WESS on existing U.S. railroads.

12120 (SAN—1731-T2) **Comparative study of the energy characteristics of powered hand tools. Part II. Investigation reports. Final report.** (Varigas Research, Inc., Timonium, MD (USA)). 1979. Contract EY-77-C-03-1731. 253p. Dep. NTIS, PC A12/MF A01.

Results are presented of a theoretical analysis and a field test program to determine the relative energy efficiencies of different types of powered hand tools. First analyzed and then tested were grinders, drills and nutrunners powered by hydraulic fluid, compressed air 60 Hz single phase electricity, three phase 180 Hz electricity, three phase 360 Hz electricity and, in the case of flexible shaft tools, three phase 60 Hz power. The work included the determination of the energy use of the total system including air compressors and frequency converters where appropriate. Distribution system losses also were considered. The result of the work is that the pneumatic tools, which have become the most popular tools in industry, use between five and fifteen times more energy than the various electrically powered tools, to do the same work. Part I of the report is intended to provide an overview of the activity and a summary of the results. Part II, Investigation Reports, is the detailed exposition of the work and results. A related report, entitled Multifrequency Factory Operations, examines the potential energy savings which accrue when higher frequency electric power is used for lighting as well as tooling.

12121 **Industrial energy conservation: in-plant recirculation of cleaned exhaust air.** Shelton, R.L. (Union Carbide Corp., Oak Ridge, TN). pp 568-575 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

The concept of recirculation as a means of energy conservation and reducing initial investment costs has received increased attention in the technical literature in recent years. The energy savings potential for recirculation systems and industrial hygiene measurements to document the performance of an actual system operating in an industrial environment are discussed. Operating experience has shown that the dual goals of industrial hygiene and energy conservation are not easily achieved.

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 12013

12122 (AD-A—065623) **Fouling effects of turbine exhaust gases on heat exchanger tubes for heat recovery systems. Research and development report for period ending March 1978.** Rogalski, R.D. (Naval Ship Research and Development Center, Annapolis, MD (USA)). Feb 1979. 48p. NTIS, PC A03/MF A01.

The use of heat recovery with shipboard gas turbine engine exhausts has generated a need to examine operational problem areas of waste heat boilers (WHB's). To ensure dependable boiler operation, it is necessary to minimize gas-side fouling of boiler tubes if the fouling cannot be eliminated. This fouling of a waste heat boiler will produce increased boiler core gas pressure drop which increases back pressure on the gas turbine propulsion engine, resulting in loss of power output and higher fuel consumption. Gas-side fouling also produces films which act as resistances to heat transfer and as media for corrosion of boiler tubes. This report summarizes work done at this Center on the subject of gas-side fouling of boiler tubes. Some of the goals of this effort are to: 1. Establish fouling film build-up rates under simulated WHB economizer tube conditions. 2. Study fouling effects on heat transfer. 3. Characterize fouling film chemistry in relation to properties of the fuel, combustion, and exhaust conditions. 4. Obtain data base of WHB design guidelines concerning fouling from several gas turbine engine exhausts.

12123 (COO—4462-1) **Rotary kiln waste energy recovery and conversion. Final report, August 1, 1977-September 30, 1978.** Benn, W.R.; Fitch, F.T.; Stecker, G.H. (Great Lakes Research Corp., Elizabethton, TN (USA)). Oct 1978. Contract EC-77-C-02-4462. 81p. Dep. NTIS, PC A05/MF A01.

Energy recovery, conversion and energy-intensive consuming processes were studied. Waste heat from the rotary kiln calcining of petroleum coke at two plant sites, Enid, Oklahoma and Port Arthur, Texas, was quantified in the study. Potential consumers were canvassed. Prospects for conservation projects are promising. Recommendations and other conclusions are described.

12124 (DOE/CS/40010—1) **High effectiveness recuperators for flue gas applications.** Coombs, M.; Jakubowski, S.T.; Smith, R.K. (Garrett Corp., Los Angeles, CA (USA). Airesearch Mfg. Div.). 18 Sep 1979. Contract EC-77-C-07-1642. 94p. Dep. NTIS, PC A05/MF A01.

The design, installation, and performance of a flue gas recuperator at a McGowan reverberatory aluminum remelt furnace are described. (TFD)

12125 (DOE/TIC—11080) **Plastic heat exchangers for waste heat recovery. ANL activity No. 49907. Quarterly report, October 1-December 31, 1979.** Koopman, R.N.; Holtz, R.E. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 3p. Dep. NTIS, PC A02/MF A01.

The program objective of Plastic Heat Exchangers for Waste Heat Recovery is to develop and apply technology for low-unit-cost plastic heat exchangers to conserve low-temperature waste heat and for other low-temperature applications. Accomplishments briefly described include coating of metal plates, composite plates, corrosion tests, and thermal performance and costs. (TFD)

12126 (NTIS/PS—79/0462) **Waste heat utilization (citations from the NTIS data base). Report for 1964-March 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). May 1979. 306p. NTIS PCN01/MF N01.

Federally-funded research on techniques of recovering waste heat from power plants, buildings, industrial processes, and waste disposal is covered. Studies of waste heat boilers and the use of waste heat for irrigation, sewage treatment, odor control, desalination, heating, and aquaculture are included. (This updated bibliography contains 299 abstracts, 46 of which are new entries to the previous edition.)

12127 (NTIS/PS—79/0463) **Waste heat utilization. Volume 3. 1977-March, 1979 (citations from the Engineering Index data base). Report for 1977-March 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). May 1979. 272p. NTIS PCN01/MF N01.

Worldwide research of waste heat from industrial process plants, electric power plants, buildings, and incineration of wastes is covered. Emphasis is on energy conservation in industrial plants. Studies of waste heat boilers and the use of waste heat for irrigation, sewage treatment, odor control, desalination, and heating are included. (This updated bibliography contains 266 abstracts, 114 of which are new entries to the previous edition.)

12128 (PB—290902) **Soil-warming for waste heat disposal, crop growth enhancement and waste water renovation. Final technical report.** DeWalle, D.R.; Fritton, D.D.; Kardos, L.T.; Knievel, D.P.; Norman, J.M. (Pennsylvania State Univ., University Park (USA). School of Forest Resources). Dec 1978. Contract DI-14-31-0001-5222. 265p. NTIS, PC A12/MF A01.

To examine the feasibility of utilization and dissipation of reject heat from power production, the effects of year-round soil-

warming on subsurface and surface heat exchange, crop growth and development and renovation of municipal waste water were determined in central Pennsylvania. The soil in a 0.09 ha test plot was artificially heated by circulating water heated to 38C through a buried, parallel pipe network. Both the heated plot and an adjacent unheated control area were irrigated weekly with about 1.5 cm of municipal sewage effluent. Measurements of soil heat flow, pipe heat loss, soil temperatures, pipe temperatures, and soil thermal conductivity were used to test theoretical steady-state models describing heat loss from a buried pipe network. The fraction of pipe heat loss dissipated by evapotranspiration was determined through the use of weighing microlysimeters. A horizontal atmospheric advection model was used to scale the small plot heat loss data to a full-sized area. Crop phases of the research focused on the effect of the warm soil on winter survival, maturation, development, yield, quality and pest relationships for alfalfa, orchardgrass, tall fescue, winter wheat, winter barley, snapbeans and sudangrass.

12129 (PB—294111) **Power plant waste heat utilization in aquaculture. Semi-annual report No. 1, 1 November 1976-1 April 1977.** Guerra, C.R.; Godfriaux, B.L.; Eble, A.F. (Public Service Electric and Gas Co., Newark, NJ (USA). Research and Development Dept.). May 1977. 96p. NTIS, PC A05/MF A01.

A pilot aquaculture facility utilizing heated river water from condenser cooling (Mercer Generating Station, Trenton, New Jersey) is being used to culture the freshwater shrimp (Macrobrachium rosenbergii) and American eel (Anguilla rostrata) during the warmer months of the year and rainbow trout (Salmo gairdneri) during the colder months. Laboratory tests are also being conducted at Rutgers University to develop shrimp feeds with supplemented amino acids in order to reduce feed costs. Most of the work during the first six months of the proof-of-concept phase of the Mercer Aquaculture Project has been concerned with facility design, groundwater well construction and trials of the groundwater on trout.

12130 (PB—294239) **Power plant waste heat utilization in aquaculture. Annual report No. 1, 1 November 1976-31 October 1977.** (Public Service Electric and Gas Co., Newark, NJ (USA). Research and Development Dept.). 1977. 176p. NTIS, PC A09/MF A01.

A pilot aquaculture facility utilizing heated river water from condenser cooling (PSEandG's Mercer Generating Station, Trenton, New Jersey) is being used to culture the freshwater shrimp (Macrobrachium rosenbergii) and American eel (Anguilla rostrata) during the warmer months of the year, and rainbow trout (Salmo gairdneri) during the colder months near Trenton, New Jersey. Twelve thousand trout were harvested from the last grow-out season. During June, 1977, juvenile shrimp 4.5 cm long were stocked at 31/sq m of total surface area in an outdoor raceway. By the end of September, 1977, the shrimp reached an average length of 7.9 cm at 11/sq m and suffered a high mortality of 58 percent. The density of 11/sq m confirms previous results in preceding years. Laboratory tests are also being conducted at Rutgers University to develop shrimp feeds with supplemented amino acids, and improve existing commercial shrimp feeds by incorporating better food binders which do not allow these food pellets to disintegrate in water as quickly.

12131 **Possibilities of combined heat recovery and air pollution control systems.** Mach, V.F. (Minnesota Energy Agency, St. Paul, MN). pp 662-671 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

Methods for combined heat recovery with air pollution control, applicable on many industrial high temperature emissions, are discussed. Two examples illustrate that such a combination offers benefit in both energy conservation and less costly protection of the environment.

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 11121, 11411, 11412, 11413, 11419, 11578, 12591

12132 (PB—291882) **An analysis of scrap futures markets for simulating resource recovery. Final report.** Anderson, R.C.; Dower, R.C. (Environmental Law Inst., Washington, DC (USA)). Dec 1978. 91p. NTIS, PC A05/MF A01.

Highly fluctuating prices for secondary materials are seen as risks in planning decisions, thus causing uncertainty and acting as a barrier to the use of secondary materials in production processes. Futures markets can provide a mechanism for transfer of price risk and decrease the uncertainty over future prices; however, commodities must possess certain characteristics to be successfully traded on futures markets. Wastepaper and ferrous scrap were analyzed for these characteristics and the results suggest that futures trading in these commodities is feasible.

12133 (PB—297978) **Three year results on the performance of incinerator residue in a bituminous base. Interim report No 2, Jun 1974-Oct 1977.** Teague, D.J.; Ledbetter, W.B. (Texas Transportation Inst., College Station (USA)). Aug 1978. Contract DOT-FH-11-8027. 69p. NTIS, PC A04/MF A01.

The use of incinerator residue as an aggregate in a bituminous base (termed littercrete) was studied. Test sections consisting of the experimental hot mixed littercrete base and a conventional hot mixed asphaltic concrete base (termed blackbase control) and topped with a conventional surface were placed on a city street in Houston, Texas. This report presents the results from observations and tests on cores during the first three years of in service performance. Results of the laboratory and field evaluations show that the littercrete section is performing in an excellent manner, almost identical with the conventional blackbase control section. The only distress that has occurred is minor cracking in both sections. This cracking is limited to the conventional wearing surface and has not progressed into the bases.

12134 (Y—2192) **Biodegradation of waste, organic machining coolants.** Davis, R.M. (Oak Ridge Y-12 Plant, TN (USA)). 27 Nov 1979. Contract W-7405-ENG-26. 23p. Dep. NTIS, PC A02/MF A01.

In 1976, developmental studies were undertaken to pursue methods of decomposition for waste machine coolants into carbon dioxide, water, and biomass using an activated-sludge biological process. During these studies, laboratory-size and pilot-plant-size reactors were operated. Reactor-operational practices were developed, and this report identifies certain significant constraints on these practices which include the following: (1) the reactor solution should be maintained in the range of 7.0 to 8.5; (2) electrically driven aerators should be operated continuously to provide oxygen and to mix the reactor contents; (3) the nitrate ion concentration should be maintained in the reactor solution in the range of 100 to 150 mg/l; the phosphate ion concentration should be 10 to 20 mg/l; and (4) waste machine coolant should be added to the reactor at the rate required to maintain a chemical-oxygen demand of < 1500 mg/l and a dissolved oxygen concentration > 1 mg/l. The development studies are complete; and, since October 1978, routine operation of the bioreactor pilot plant has been controlled by Chemical Services Department personnel.

MUNICIPALITIES AND COMMUNITY SYSTEMS

12135 **Clearwater's energy policy plan.** Clearwater, FL; City of Clearwater (1979). 160p. (NP—24205).

The energy problem facing Clearwater and the nation is a result of the collision of two facts which are carefully documented in Section 1 of the Energ Policy Plan: (1) at present the economic strength of the western industrial nations is entirely dependent upon petroleum and natural gas, and (2) supplies of petroleum and natural gas will fail to meet demand around or before 1990. Section 1 also deals with the potential effects of this collision. Section II, using population projections and land-use and economic forecasts developed for the City by the Planning Department, projects the city's future energy supply and demand trends. Section III reviews the existing energy-management program and provides the framework necessary for the expanded development and implementation of the energy-conservation policies and programs which will further mitigate the local hardships of the coming transition period. Surveys indicate Clearwater can reduce its energy consumption by 25% without detracting from the presently attainable quality of life in Clearwater. (MCW)

CONSERVATION SERVICES

REFER ALSO TO CITATION(S) 12020

PUBLIC UTILITIES

REFER ALSO TO CITATION(S) 11197, 11838, 11987, 12027

12136 (ANL/CNSV-TM—18) **Heat-pump-centered integrated community energy systems. Final report.** (Honeywell, Inc., Minneapolis, MN (USA). Energy Resources Center). Nov 1979. Contract W-31-109-ENG-38. 214p. Dep. NTIS, PC A10/MF A01.

A Heat Pump Centered-Integrated Community Energy System (HP-ICES) concept was explored and developed that is based on use of privately owned ice-making heat pumps in each building or complex within a community. These heat pumps will provide all of the space heating, space cooling and domestic hot water needs. All of the community input energy required is provided by electrical power, thereby eliminating a community's dependence on gas or oil supplies. The heat pumps will operate in both air and water source modes, deriving performance advantages of both. The possible forms of an HP-ICES system, the technical and economic limitations, environmental impacts and other factors are discussed

from a general viewpoint. The concept is applied to a specific planned community and its performance and economic features are examined in detail. It is concluded that the HP-ICES concept is technically viable, but that its economic desirability as compared with conventional heat pump systems is hampered by much higher initial costs, and that the economic feasibility of HP-ICES systems will depend on future fuel source costs and supply and on electric power rates. (LCL)

12137 Developing and implementing a municipal energy program. Hufford, H.; Brooks, S.; Hall, A.; Southworth, N. (City Utilities, Springfield, MO). pp 424-429 of Fifth annual UMR-DNR conference on energy. Morgan, J.D. (ed.). Rolla, MO; Univ. of Missouri (1978).

From 5. conference on energy; Rolla, MO, USA (Oct 1978).

Faced with the responsibility of providing energy and water services for a rapidly-growing community, City Utilities is looking for ways to encourage more efficient use of our available energy resources. The progress made and some of the pitfalls encountered by a municipal utility during implementation of energy programs as part of a federal, pilot demonstration project are described.

MUNICIPAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 11418

12138 (AD-A—065415) 72-hour operating test of a packaged heat recovery incinerator. Final report. Anderson, L.W. (Systems Technology Corp., Xenia, OH (USA)). Aug 1978. Contract N68305-77-C-0037. 75p. NTIS PC A04/MF A01.

The performance of the North Little Rock, AR, municipal heat recovery incinerator installation was monitored over a 4-day period. The average energy contents of the solid waste, as fixed, was 3800 Btu/lb. The average conversion efficiency over the 4-day period was found to be 50.7% based upon the low heating value of the solid waste.

12139 (ANL/ES—78) Simulation of waste treatment (SWAT) model: a method for cost-effectiveness analyses of wastewater treatment strategies. Macal, C.M. (Argonne National Lab., IL (USA)). Dec 1978. Contract W-31-109-ENG-38. 47p. Dep. NTIS, PC A03/MF A01.

A computer simulation model for estimating municipal wastewater treatment costs, referred to as SWAT (Simulation of Waste Treatment) model is described. The model can be used as a policy planning tool to construct relationships between cost and effluent quality across technologies for a river basin. Wastewater treatment technology is represented in detail. Costs of operation and modification in response to changes in effluent standards are simulated over a planning period. Replacement technology at the time of plant modification is selected automatically by the model considering the equipment in place at a plant and costs of alternate technologies. The model is unusual in that the interactions of pollutant treatments are explicitly considered and information on the existing treatment systems in a basin is taken into account. An analytical framework is presented to illustrate how the model represents treatment technology and estimates costs. The model's capabilities are discussed and sample output is presented to show how the SWAT model can be used as a policy planning tool.

12140 (BM-RI—8390) Incinerated municipal sewage sludge as a potential secondary resource for metals and phosphorus. Gabler, R.C. Jr. (Bureau of Mines, Avondale, MD (USA). Avondale Metallurgy Research Center). 1979. 25p. Bureau of Mines, Pittsburgh, PA.

Evaluation of incinerated sewage sludge as a secondary resource for aluminum, phosphorus, and minor constituents such as copper and zinc was initiated as part of the Bureau of Mines secondary resource program. The elemental composition of sludge ash for 14 plants in 11 US cities was determined. Comparing industrialized cities with cities where most of the sewage is domestic, significant differences in heavy metal content were noted. Various parameters were investigated affecting the extraction of metals and phosphorus from a typical industrial city sludge ash and from a Palo Alto, California sludge ash with a high precious metal content. Three extraction-recovery procedures for metals and phosphorus using sulfuric acid leaching, ion exchange, and various precipitation techniques were investigated. The last procedure developed was a combination approach using a three-stage countercurrent sulfuric acid leach that recovered most of the economic values from the sludge ash and also removed the leachable fraction of elements of environmental concern.

12141 (BM-RI—8404) Detinning ferrous products from urban waste for use in steelmaking. Makar, H.V.; Wiegard, B.J. Jr.; Gresh, E.L. III. (Bureau of Mines, Avondale, MD (USA). Avondale Metallurgy Research Center). 1979. 19p. Bureau of Mines, Pittsburgh, PA.

Ferrous fractions recovered from urban refuse were tested by the US Bureau of Mines, US Department of the Interior, to assess their character, composition, and response to detinning. This research was conducted as part of the Bureau's efforts to conserve mineral resources through recycling. Results from laboratory and pilot tests established the technical feasibility of detinning scrap recovered from household refuse. Detinned products containing less than 0.03% residual tin were produced. Concentrations of other residual elements were determined and compared with those in existing commercial scrap and with proposed specifications. Studies were extended to include evaluations under commercial conditions. Preliminary tests on 5-1/2 short tons of ferrous fractions revealed the need for adequate shredding to assure optimum metal-caustic contact and minimize retention of tin-bearing rinse solution in the final baled product. The washed metal product contained 0.06% residual tin. Subsequent melt tests showed a yield of 91.4%. Based on these studies, full-scale commercial demonstrations showed that detinned bales equivalent to No. 1 bundle quality could be produced in carload quantities. Up to 5 lb of tin per gross ton of scrap is concurrently recovered during the detinning process.

12142 (INIS-mf—5239, pp 97-126) Summary of recent developments in the sludge irradiation program at Sandia laboratories. Morris, M.E.; Sivinski, J.S.; Brandon, J.R.; Neuhauser, K.S.; Ward, R.L. (Sandia Labs., Albuquerque, NM (USA)). Sep 1978.

From 3. international conference of ENSA working group on waste irradiation; Brno, Czechoslovakia (4 Sep 1978).

Sandia Laboratories has shifted the emphasis of its Sewage Sludge Irradiation Program toward treating dried sewage sludges rather than liquid sludges for the following reasons: (1) cities' interests in composting sewage sludge before final disposal; (2) need for disinfection of the product before sale to the public; and (3) low cost of disinfection by radiation processing. As a result of this shift, the Sandia Irradiator for Dried Sewage Solids (SIDSS), was designed and is near completion. The irradiator will treat up to 8 tons/day of solids with a 1 megarad absorbed dose. A bucket conveyor will transport the sewage sludge past a 1 megacurie cesium-137 γ-ray source. If a lower dose than 1 megarad is acceptable for disinfection, the daily throughput of the irradiator will be correspondingly increased. The irradiator is designed so that the cesium-137 γ-ray sources used to charge the facility can be manipulated underwater. After source unloading is complete, the water will be drained and the irradiator will be operated dry. Either bagged or bulk solids can be irradiated with the system.

12143 (NTIS/PS—79/0483) Regional and urban solid waste disposal. Part 1. Management planning (a bibliography with abstracts). Report for 1964-April 1979. Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). May 1979. 253p. NTIS PCN01/MF N01.

Management, state, and local government policies, legislation, financing, data acquisition, and general planning studies for urban and regional solid waste disposal systems are covered. The topics include comments on public health, landfills, pollution, recycling, and load use. Studies on energy recovery and consumption, environmental impacts, land use, guidelines, and models are also covered. (This updated bibliography contains 246 abstracts, 20 of which are new entries to the previous edition.)

12144 (NTIS/PS—79/0484) Regional and urban solid waste disposal. Part 2. Local case studies (a bibliography with abstracts). Report for 1964-April 1979. Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). May 1979. 221p. NTIS PCN01/MF N01.

Case studies are cited on municipal waste disposal in specific cities, counties, or regions. These studies include aspects of collection, hauling, incineration, sanitary landfills, ocean dumping, and transfer stations as applied to a specific locale. Management studies designed only for these areas are also included. (This updated bibliography contains 214 abstracts, 25 of which are new entries to the previous edition.)

12145 (NTIS/PS—79/0485) Regional and urban solid waste disposal. Part 3. Handling and disposal technology (a bibliography with abstracts). Report for 1964-April 1979. Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). May 1979. 258p. NTIS PCN01/MF N01.

The citations cover the technology and techniques of collection, hauling, sorting, processing, disposal, incineration, and recycling of urban wastes. These abstracts were chosen to describe methods and equipment for waste handling, disposal, or reclamation. In addition, studies on refuse derived fuels and energy consumption in solid waste processing are covered. (This updated bibliography contains 251 abstracts, 13 of which are new entries to the previous edition.)

12146 (SAND—78-1366) Sandia Irradiator for Dried Sewage Solids. Preliminary safety analysis report. Morris, M.E. (Sandia Labs., Albuquerque, NM (USA)). Dec 1979. Contract EY-76-C-04-0789. 102p. Dep. NTIS, PC A06/MF A01.

This safety analysis report describes the Sandia Irradiator for Dried Sewage Solids (SIDSS) designed by Sandia Laboratories and

assesses the hazards associated with its operation. The SIDSS consists of a conveyor system, a source plaque and associated shielding, and a gamma-source pin loading/unloading pool. The facility will be installed next to Building 6720 in Technical Area III (TA-III) in July 1978. This facility will provide Sandia Laboratories with the capability of exposing up to 8 tons per day of sewage solids to 1 Mrad absorbed dose.

EDUCATION AND PUBLIC RELATIONS

REFER ALSO TO CITATION(S) 12094

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

REFER ALSO TO CITATION(S) 12108, 12109, 12164, 12165

12147 (COO—4492-1) **Heterogeneous engine in-cylinder mixing measurements using a tracer technique-Part I. Final report.** Turns, S.R.; Borman, G.L. (Wisconsin Univ., Madison (USA)). Mar 1979. Contract EC-77-S-02-4492. 327p. Dep. NTIS, PC A15/MF A01.

Gas-sampling characteristics of engine sampling probes were determined to assist in interpretation of engine sampling data. Of the many sources of sampling error, three were chosen for investigation: the flow disturbance associated with a probe's sink action, the flow disturbance associated with a probe's presence, and the bulk-gas sample bias caused by flame quenching at the probe's surface. Flow disturbance errors were determined by conducting experiments in a steady-flow rig, while estimates of quench-gas bias were determined principally by mathematical modeling.

SPARK-IGNITION

REFER ALSO TO CITATION(S) 12160, 12166

12148 (PB—293842) **Analysis of hot/cold cycle requirements for heavy-duty vehicles. Technical report.** France, C.J. (Environmental Protection Agency, Ann Arbor, MI (USA)). Jul 1978. 76p. NTIS, PC A05/MF A01.

EPA has recently been involved in the development of transient engine and chassis cycles from the CAPE-21 survey data. The CAPE-21 survey data was gathered from eighty-eight in-use trucks; forty-four in New York City and forty-four in Los Angeles. Vehicle speed, engine rpm, engine power, engine temperature, and various traffic and road describers were recorded on tape, at approximately one second intervals. Prior to the actual generation of the cycles, the need for a unique cold start cycle (engine and/or chassis) was investigated. This report summarizes this investigation.

12149 (PB—294088) **Category selection for transient heavy-duty and engine cycles. Technical support report for regulatory action.** France, C.J. (Environmental Protection Agency, Ann Arbor, MI (USA)). May 1978. 78p. NTIS, PC A05/MF A01.

The Emission Control Technology Division (ECTD) of EPA has generated heavy-duty transient engine and chassis cycles representative of the truck operational data collected during the CAPE-21 survey. This report summarizes the considerations and decision process used in arriving at the final vehicle categories for which heavy-duty transient cycles were developed. Statistical comparisons between various operational parameters were primarily relied upon in selecting the valid category combinations. It was possible to reduce the original number of vehicle categories from 28 to 9 for engine cycles and from 28 to 5 for chassis cycles.

12150 (PB—294221) **Selection of transient cycles for heavy-duty vehicles. Technical report.** Wysor, T.; France, C. (Environmental Protection Agency, Ann Arbor, MI (USA)). Jun 1978. 17p. NTIS, PC A02/MF A01.

A result of EPA's heavy-duty cycle development project has been the computer-generation of some 35 candidate chassis cycles by the contractor, Olson Labs. This collection of cycles, synthesized from actual urban driving data, has been narrowed down by EPA to four cycles representing truck operation under both freeway and non-freeway conditions in Los Angeles and New York. In an effort to choose a cycle for each category which best represented the actual data, EPA scored the candidates according to their summary statistics, provided by Olson with each cycle.

DIESEL

REFER ALSO TO CITATION(S) 12148, 12149, 12150, 12166, 12167

12151 (COO—4492-2) **Heterogeneous engine in-cylinder mixing measurements using a tracer technique: Part 2. Final report.** Jessel, A.J.; Borman, G.L. (Wisconsin Univ., Madison (USA)). Mar 1979. Contract EC-77-S-02-4492. 131p. Dep. NTIS, PC A07/MF A01.

A diagnostic technique for determining fluid motion and mixing in heterogeneous internal combustion engines was developed and tested. Once per cycle, a rapid-acting valve injected a small, discrete quantity of a gaseous tracer directly into the combustion chamber. At a specific place and time after tracer injection, a similar valve extracted a small quantity of cylinder gas which was analyzed for cycle averaged tracer concentration. For motored engine tests, an ethane/nitrogen mixture was used as the tracer with a flame ionization detector for gas analysis. Radioactive argon was employed as the tracer for fired engine tests with a sodium iodide scintillation counter as a detector. A mapping in time and space of tracer motion was constructed from data and sources of error discussed. The apparatus worked quite well. The test engine was an open-chambered single-cylinder diesel. Data taken just prior to top center of the compression stroke indicated that the tracer puff remained largely unmixed with air over the short distance between injection and sampling valves. A swirl rate of 2.5 was calculated from motoring data. Firing results showed the tracer pulse higher in peak concentration and more compact than for the motored case.

TURBINE

REFER ALSO TO CITATION(S) 12161, 12162

12152 (COO—2749-27) **Baseline gas turbine development program. Twenty-first quarterly progress report.** (Chrysler Corp., Detroit, MI (USA)). 31 Jan 1978. Contract EY-76-C-02-2749. 74p. Dep. NTIS, PC A04/MF A01.

Progress is reported for a program whose goals are to demonstrate an experimental upgraded gas turbine-powered automobile which meets the 1978 Federal Emissions Standards, has significantly improved fuel economy, and is competitive in performance, reliability, and potential manufacturing cost with the conventional piston engine-powered, compact-size American automobile. Activity during this twenty-first program quarter has continued to emphasize development towards correcting a power deficiency in the upgraded engine. Efforts are also being directed towards reducing fuel usage through improved heat recovery and towards improving the mechanical reliability and control of the engine.

EXTERNAL COMBUSTION ENGINES

STIRLING CYCLE

12153 (PB—293940) **Alternate engines - state of the art study. Final report, November 1977-November 1978.** Renner, R.A. (South Coast Technology, Inc., Santa Barbara, CA (USA)). Nov 1978. Contract DOT-HS-7-01790. 85p. NTIS, PC A05/MF A01.

Eleven different advanced automobile engine types were examined as to the possibilities for introduction prior to 1990. An assessment was made based on extensive literature survey and extrapolation of learning curves toward future values of fuel economy and emissions. Gas turbines and external combustion engines are unlikely to be in general use prior to 1990. Stratified charge engine, the advanced diesel, and internal combustion engines with variable displacement features were considered to be likely candidates for use prior to 1990. These engines were analyzed and learning curves were determined for fuel economy predictions with exhaust emission constraints.

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 11974, 11975, 12158

12154 (ANL/OEPM—78-12) **Research, development and demonstration of nickel-zinc batteries for electric vehicle propulsion. Annual report, 1978.** (Yardney Electric Corp., Pawcatuck, CT (USA)). Oct 1979. Contract W-31-109-ENG-38. 64p. Dep. NTIS, PC A04/MF A01.

The work carried out under the Yardney Contract with ANL for R, D and D on nickel zinc batteries over the past year was directed in three major areas: (1) elucidating the failure modes of the nickel-zinc battery system; (2) improving performance of the system; and (3) effecting a cost reduction program. Progress on the three areas is reported. (TFD)

12155 (DOE/CS—0026-8) **Electric & Hybrid Vehicle Program. Quarterly report, July-September 1979.** (Department of Energy, Washington, DC (USA). Office of Transportation Programs). Nov 1979. Contract EC-77-A-31-1044. 27p. Dep. NTIS, PC A03/MF A01.

Progress in US Programs on the design, development, production, performance testing, and commercialization of electric and hybrid electric-powered vehicles is briefly summarized. (TFD)

12156 (DOE/CS/51180—1) **Updated projections of air quality impacts for electric cars.** Collins, M.M. (General Research Corp., Santa Barbara, CA (USA)). Jul 1979. Contract EY-76-C-03-1180. 126p. Dep. NTIS, PC A07/MF A01.

Future air pollution emissions and resulting air quality are projected for the five primary air pollutants: total suspended particulates (TSP), sulfur oxides (SO/sub x/), nitrogen oxides (NO/sub x), total hydrocarbons (THC), and carbon monoxide (CO). Separate projections are made for three future years - 1980, 1990, and 2000 - and for three assumed levels of electric car use - zero, 10%, and 100%. Emissions and air quality are analyzed for each of the 24 Air Quality Control Regions (AQCRs) having the largest populations in 1975. Emission projections are made using an improved version of the Regional Emissions Projection System which uses the 1975 National Emissions Data System, 1977 state OBERS growth projections, recent state implementation plans and new source performance standards, and electric utility fuel forecasts from the Recharge Capacity Projection System.

12157 **Promise and puzzle of electric vehicles.** *EPRI J.;* **4**: No. 9, 6-15(Nov 1979).

The electric vehicle (EV), after lying dormant for half a century, is being revived as a strategy for reducing oil dependence and urban pollution. Large-scale battery research programs are underway, but every element of the transportation infrastructure must respond in order to support mass production and widespread use of EVs. Energy delivery, parts manufacture and service, maintenance, and insurance must all be developed and integrated into a complete system. The social benefits have increased, but the obstacles have also become more complex. Successful EV marketing will depend on petroleum supplies and prices, synthetic fuel performance, air and noise pollution laws, cooperation between the private and public sectors, and whether the EV range can be adequately extended.

HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 12155

12158 (CONF-791009—23) **Electric and hybrid vehicles in the urban future.** Singh, M.K.; Bernard, M.J. III. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 11p. Dep. NTIS, PC A02/MF A01.

From International conference on energy use management; Los Angeles, CA, USA (22 Oct 1979).

Electric and hybrid vehicles (EHVs) are under development which could provide an alternative to conventional vehicles in urban areas in the not-too-distant future. The purpose of this paper is to present basic EHV information to transportation energy planners and engineers. The paper outlines: (1) the market potential for EHVs (trucks, buses, and automobiles) based on the work of several research groups and on expected technological characteristics of EHVs; (2) an assessment of the impacts of EHVs on the urban structure and transport systems as well as urban enviromental systems; and (3) current programs designed to accelerate the utilization of EHVs. In the assessment 61 types of vehicles are characterized and set in five distinct market scenarios. The paper concludes that the potential for significant EHV markets by the year 2000 is high and an overall net benefit to urban areas will result.

VEHICLE DESIGN FACTORS

12159 (PB—290516) **Automotive fuel economy contractor's coordination meeting held at Washington, DC on December 11-13, 1978. Summary report.** (National Highway Traffic Safety Administration, Washington, DC (USA). Technology Assessment Div.). 1978. 427p. NTIS, PC A19/MF A01.

This document is intended to be an effective and timely means of broadly disseminating a full and up-to-date review of the automotive fuel economy research and analysis program objectives and progress. Topic areas covered include: Fuel economy and emissions considerations; Motor vehicle demand forecasting; Consumer research; Engines; Weight reduction; and Industrial behavior.

ENGINE-TRANSMISSION MATCHING

12160 (PB—293728) **Evaluation of automobile drivetrain components to improve fuel economy. Final report June 1975-November 1977.** Hurter, D.; Gott, P. (Little (Arthur D.), Inc., Cambridge, MA (USA)). Mar 1979. Contract DOT-TSC-1046. 114p. NTIS, PC A06/MF A01.

Wide ratio range automatic transmissions with lockup torque converters could be in production by the early 1980's. In order to evaluate their impact upon fuel economy, emissions, driveability, acceleration, and durability, four 1975 Chrysler automobiles with inertia weights and engine sizes typical of that time period were equipped with Multi-Purpose Test Transmissions. These transmissions could duplicate: current three-speed automatic transmissions; wide range three-speed automatic transmissions; and wide range four-speed automatic transmissions with or without torque converter lockup. Each of the test cars were evaluated in seven different transmission modes for fuel economy, emissions, driveability, acceleration, and durability. Fuel economy test results were compared to computer predicted fuel economies. Predicted values agreed with actual fuel economies within the resolution of the test method. Composite fuel economy improvements of up to 14% were achieved with no change in acceleration and durability. Further development work is required to bring emissions and driveability to acceptable levels. Maximum increases in fuel economy due to drivetrain improvements have not been demonstrated due to the possibility for further optimization of engine road load matching and the impacts of emission and driveability modifications.

EMISSION CONTROL

REFER ALSO TO CITATION(S) 12153, 12156, 12159, 12321

12161 (N—79-20116) **JT8D abd JT9D jet engine performance improvement program. Task 1: feasibility analysis. Final report, February - December 1977.** Gaffin, W.O.; Webb, D.E. (Pratt and Whitney Aircraft, East Hartford, CT (USA). Commercial Products Div.). Apr 1979. Contract NAS3-20630. 227p. NTIS, PC A11/MF A01.

JT8D and JT9D component performance improvement concepts which have a high probability of incorporation into production engines were indentified and ranked. An evaluation method based on airline payback period was developed for the purpose of identifying the most promising concepts. The method used available test data and analytical models along with conceptual/preliminary designs to predict the performance improvements, weight, installation characteristics, cost for new production and retrofit, maintenance cost, and qualitative characteristics of candidate concepts. These results were used to arrive at the concept payback period, which is the time required for an airline to recover the investment cost of concept implementation.

12162 (N—79-20528) **Effects of air injection on a turbocharged Teledyne Continential Motors TSIO-360-c engine.** Cosgrove, D.V.; Kempke, E.E. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1979. 37p. NTIS, PC A03/MF A01.

A turbocharged fuel injected aircraft engine was operated over a range of test conditions that included that EPA five-mode emissions cycle and fuel air ratio variations for individual modes while injecting air into the exhaust gas. Air injection resulted in a decrease of hydrocarbons and carbon monoxide while exceeding the maximum recommended turbine inlet temperature of 1650 F at the full rich mixture of the engine. Leanout tests indicated that the EPA standards could be met through the combined use of fuel management and air injection.

12163 (PB—290611) **Evaluation of a proposed Colorado state inspection/maintenance program. Technical report.** Bejma, T.C. (Environmental Protection Agency, Ann Arbor, MI (USA)). Nov 1978. 15p. NTIS, PC A02/MF A01.

The results of this pilot effort confirm the poor emission performance of relatively new, in-use passenger cars although 1977 and 1978 automobiles displayed better control than those prior to confirmatory testing at high altitude. The underhood inspections revealed that many vehicles had been subjected to various forms of maladjustments, primarily ignition timing and idle mixture. It was found that a resonable I/M program at high altitude would be effective in identifying higher emitters.

12164 (PB—293529) **Exhaust emissions and fuel consumption of a heavy-duty gasoline powered vehicle over various driving cycles - 361 cubic inch 1966 Ford F-600. Technical report.** Nash, R. (Environmental Protection Agency, Ann Arbor, MI (USA)). Aug 1978. 24p. NTIS PC A02/MF A01.

This report contains the results of exhaust emission tests on one precontrolled heavy-duty gasoline truck. These tests were run on a chass's dynamometer over various cycles developed under the

CAPE-21 cycle generation program. This effort is a continuation of the test program which initially examined a 1977 GMC truck; it was designed to answer some questions which developed during that testing. This test sequence was designed to investigate in more detail the effect of various driving cycles upon vehicle emissions and fuel consumption. For this reason, road load drag force was not varied as in the previous experiment. For each driving cycle three tests were run with the vehicle in a fully warmed-up condition. Also, for this test sequence, several new cycles were generated which had not been run during the previous test sequence on the GMC truck. (See Technical Support Report for Regulatory Action, Exhaust Emissions and Fuel Consumption of a Heavy-Duty Gasoline Powered Vehicle over Various Driving Cycles, 427 Cubic Inch 1977 California GMC 6500, June 1978). The final phase was a sequence of four tests to investigate cold and warm start effects.

12165 (PB—293530) **Exhaust emissions and fuel consumption of a heavy-duty gasoline powered vehicle over various driving cycles - 427 cubic inch 1977 california GMC 6500. Technical report.** Nash, R. (Environmental Protection Agency, Ann Arbor, MI (USA)). Aug 1978. 42p. NTIS PC A03/MF A01.

This report presents exhaust emission and fuel economy measurements for one heavy-duty gasoline fueled vehicle operated over various driving cycles. These driving cycles were developed from actual in-use operational data collected in New York and Los Angeles under the CAPE-21 program. In each location, both freeway and non-freeway operational parameters were recorded. A data matrix (relating speed, acceleration and frequency of occurrance) was prepared for each city and class of operation. Several different cycles were generated for each matrix. Evaluation of the concept of chassis testing for heavy-duty vehicles were the major purpose of this project. The test program was designed to measure the sensitivity of exhaust emissions and fuel economy to the various driving cycles and road load conditions. In addition, a brief attempt was made to characterize cold start emissions and the effects of increased vehicle frontal area. Three of the fully transient cycles were 'linearized' (steady state cruises and constant accelerations) to see if a simpler type of transient operation could accurately predict fuel economy. Finally, experiments were undertaken to measure the instantaneous exhaust dilution ration in order to assess the adequacy of the CVS flow rate.

12166 (PB—293764) **Transient cycle arrangement for heavy-duty engine and chassis emission testing. Technical report.** France, C.J. (Environmental Protection Agency, Ann Arbor, MI (USA)). Aug 1978. 46p. NTIS, PC A03/MF A01.

Olson Laboratories, EPA's heavy-duty cycle development contractor, has generated various nominal 5-minute chassis and engine cycles from the CAPE-21 data base. The Emission Control Technology Division of EPA has in turn, selected the best cycle in each category for which cycles were generated (both chassis and engine cycles). The final step in ECTD's HD transient cycle development effort is the arrangement of these five minute cycles into one cycle which exhibits the proper trip characteristics as determined from the CAPE-21 survey data. The purpose of this report is to identify the cycle arrangement that has the proper trip characteristics and which also meets certain practical requirements. Chassis and engine cycle arrangements for both HD gasoline and diesel vehicles are developed. The equations necessary for exhaust emission calculations are also presented.

12167 (PB—293766) **Exhaust emissions and fuel consumption of a heavy duty diesel vehicle over various driving cycles - GMC Astro 95, 8v-71 na. Technical report.** (Environmental Protection Agency, Ann Arbor, MI (USA)). Aug 1978. 51p. NTIS, PC A04/MF A01.

This report presents exhaust emissions and fuel economy measurements for one heavy-duty diesel vehicle operated over various driving cycles. These driving cycles were developed from actual in-use operational data collected in New York and Los Angeles under the CAPE-21 program. In each location, data collected for freeway and non-freeway operation was segregated. A data matrix (relating speed, acceleration and frequency of occurance) was prepared for each city and type of operation. The test program was designed to evaluate the concept of chassis testing for large diesel vehicles. Along with this goal, it was desired to determine emission factors and fuel consumption by category of operation and to determine the variation with vehicle load. Also, to verify the cycle generation technique, the sensitivity of emissions and fuel consumption was to be established. Finally, the effect of 'linearized' cycles, steady state tests cold start operation were evaluated.

12168 (PB—294371) **Application for certification for 1979 model year for light-duty vehicles - ford motor company.** (Ford Motor Co., Dearborn, MI (USA)). 21 Nov 1978. 4632p. Also available in set of 20 reports PC$1460.00, MF$51.00, PB-294 367-SET.

Every year, each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

12169 (PB—294390) **Application for certification for 1979 model year for heavy-duty vehicle - ford motor company.** (Ford Motor Co., Dearborn, MI (USA)). 21 Nov 1978. 1067p. Also available in set of 7 reports PC$250.00, MF$12.00, PB-294 388-SET.

Every year, each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

ALTERNATIVE FUELS

12170 (PB—290569) **Gasohol test program. Technical report.** Lawrence, R. (Environmental Protection Agency, Ann Arbor, MI (USA)). Dec 1978. 42p. NTIS, PC A03/MF A01.

Eleven vehicles (4 three-way systems and 7 oxidation catalyst systems) were tested on five fuels. A summer grade gasoline was selected as the base fuel and was used both before and after testing on the two commercial gasohols. Indolene and a gasohol fuel containing indolene and ethanol were the other two fuels. All gasohol fuels used in this program contained 10 percent ethanol (by volume). Duplicate tests were planned on four fuels and four tests were planned on the base fuel.

12171 (PB—290612) **Exhaust emissions and fuel economy from automobiles using alcohol/gasoline blends under high-altitude conditions. Technical report.** Richardson, D. (Environmental Protection Agency, Ann Arbor, MI (USA)). Oct 1978. 28p. NTIS, PC A03/MF A01.

This paper, describes the results of emissions tests on ten passenger cars operated on fuel blends containing methanol and ethanol. The purpose of the program was to determine the immediate exhaust emission and fuel economy changes due to use of alcohol/gasoline blends under high altitude conditions. The vehicles represented the 1973-1978 model years and were randomly selected from private owners in the Denver area. The test procedures used were the Federal Test Procedure (exhaust emissions only) and the Highway Fuel Economy Test. Fuel economy was measured and recorded using the carbon balance technique.

MATERIALS

12172 (DOE/ER—0035) **Review of the management of materials research and development in the Department of Energy. Final report.** (Department of Energy, Washington, DC (USA). Office of Energy Research). Dec 1979. 134p. Dep. NTIS, PC A07/MF A01.

The Materials Working Group of DOE findings and recommendations of a management nature to improve the handling of materials R and D within DOE are presented. The special role of materials in the development of new energy technologies is provided. (FS)

METALS AND ALLOYS

REFER ALSO TO CITATION(S) 11033, 11034, 11081

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 11068, 12187, 12192, 12195

12173 (N—79-19113) **Chemical vapor deposition of high T sub c superconductors. Final report, 1 May 1975 - 31 December 1978.** Webb, G.W.; Engelhardt, J.J. (California Univ., San Diego, La Jolla (USA). Inst. of Pure and Applied Physical Sciences). 31 Dec 1978. 60p. NTIS PC A04/MF A01.

The results are reported of an investigation into the synthesis and properties of high temperature superconducting materials. A chemical vapor deposition apparatus was designed and built which is suitable for the preparation of multicomponent metal films This apparatus was used to prepare a series of high T sub c A-15 structure superconducting films in the binary system Nb-Ge. The effect on T sub c of a variety of substrate materials was investigated. An extensive series of ternary alloys were also prepared. Conditions allowing the brittle high T sub c (approximately 18 K) A-15 structure superconductor Nb3A1 to be prepared in a low T sub c but ductile form were found. Some of the ways that the ductile (bcc) form can be cold worked or machined are described. Measurements of rate of transformation of cold worked bcc material to the high T sub c A-15 structure with low temperature annealing are given. Preliminary measurements indicate that this material has attractive high field critical current densities.

12174 (RDT-F—6-5T(1-80)(Rev.)) **Welding and brazing qualifications (supplement to ASME boiler and pressure vessel code, Section IX).** (Department of Energy, Washington, DC (USA). Office of Nuclear Energy Programs). Jan 1980. Contract W-7405-ENG-26. 55p. RSO.

This standard supplements the requirements of the 1977 edition of the ASME Boiler and Pressure Vessel Code (the Code), Section IX. When this standard is invoked or referenced, the applicable subsections of Section IX of the Code are also invoked or referenced. The paragraph numbers apply only to the 1977 edition of Section IX and its addenda. The user of this standard is responsible for obtaining and applying the edition and revision of this standard that supplement the edition and Addenda of Section IX that are in legal effect at the time of use.

12175 **Strain aging in α-zirconium and α-zircaloy at 1000 K.** Garde, A.M. (Argonne National Lab., IL (USA)). *J. Nucl. Mater.;* **80**: No. 2, 195-206(May 1979).

Tensile deformation of fine grain-size zirconium and zircaloy-2 and -4 sheet specimens was investigated near 1000°K at strain rates between 10^{-4} and $10^{-2}s^{-1}$. Manifestations of dynamic strain aging, e.g., yield-point effect and rate-dependent work-hardening behavior, were evident in the materials. Also, the uniform strain versus temperature curve exhibited a minimum. Yield-point type transients following extension-rate change, serrated stress-strain curves, and flow-stress peaks were recorded for both zircaloys. A microstructure with a smaller volume fraction of second-phase particles is more conducive to the yield-point effect. An analysis of the composition of second-phase particles implies that iron atoms in solution are responsible for strain aging in zirconium and the zircaloys at 1000°K.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 12197, 12198

12176 (LBL—9956) **Mechanism of microstructural change and its consequences in a low carbon Fe-6Ni alloy.** Kim, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-26. 132p. Dep. NTIS, PC A07/MF A01.

Thesis.

The mechanism of microstructural changes during a three step thermomechanical treatment and the effects of resulting microstructures on mechanical properties were investigated in a low carbon Fe-6Ni alloy. Especially emphasized in this study were changes in grain size and the process of formation of the precipitated austenite. Refinement of the grain size appeared to be achieved after two step treatment. Heating by temperature cycling up to the austenite reversion temperature was found primarily to refine prior austenite grains. Controlled rolling was revealed to be an effective means to replace these thermal cyclings. (α + γ) two-phase tempering showed ultrafine grains through two-phase decomposition and development of subgrains with large angle grain boundaries. A minimum of two thermal treatments in the (α + γ) two-phase region appeared necessary for a formation of stable retained austenite.

12177 (PNL-SA—7229) **Phase stability of amorphous intermetallic alloys.** Wang, R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1979. Contract EY-76-C-06-1830. 4p. (CONF-790219—14). Dep. NTIS, PC A02/MF A01.

From AIME annual meeting; New Orleans, LA, USA (18 Feb 1979).

Phase stability of amorphous intermetallic alloys, in terms of both formation and thermal stability, can be related to the alloy chemistry of the crystalline counterpart: the intermetallic compounds. The formation of the amorphous alloys is generally favored by the composition range in which the complex-structured intermetallic compounds and nearby eutectic point are present. The relative thermal stability of the amorphous intermetallic alloys, expressed by the reduced crystallization temperature, T/sub rc/, (T/sub rc/= T/sub c/T/sub m/, where T/sub c/ is the crystallization temperature °K, and T/sub m/ the melting temperature of the crystallized phase °K) increases with the increasing of the structural complexity of the crystalline counterparts. Based on recent data of amorphous intertransiton metal alloys, T/sub rc/ increases rapidly from less than 0.1 for the simple structures of bcc, fcc, or hcp, to nearly 0.4 for more complex structures such as A15, Laves-, σ- and $CaCu_5$-phases up to 0.6 for highly complex structures of eta-, δ-, and μ-phases. It can therefore be argued that alloy principles for the equilibrium compounds can be applied to the phase stability of the amorphous intermetallic alloys.

12178 **Stability of the body-centered cubic gamma phase in the uranium-zirconium-niobium system.** Williams, R.O. (Oak Ridge National Lab., TN (USA)). *J. Nucl. Mater.;* **82**: No. 1, 184-192(Jun 1979).

A thermodynamic representation of the stability of the binary gamma phases has been developed for the U-Zr, U-Nb and Zr-Nb binary systems. This has permitted the calculation of the miscibility gaps in the ternary system. The three binary gaps merge to form a large three-phase region in the middle of the composition trangle. Because of the large coherency energies, the spinodal decomposition in the U-Nb and Zr-Nb gaps will be drastically modified, but a large region remains in the ternary system where the decomposition products have small coherency energies such that spinodal decomposition is probable. From these results, the author has identified the four decomposition processes in Mulberry (U-16.6 at% Nb-5.6 at% Zr) as being discontinuous and spinodal decomposition within the miscibility gap, the diffusionless formation of a and the formation of (α + γ) from the supersaturated gamma phase.

12179 **In-situ electrical-resistivity measurements in the high-voltage electron microscope.** King, W.E. (Northwestern Univ., Evanston, IL). pp 68-69 of Ninth international congress on electron microscopy. Vol. 1. Toronto, Ontario; Microscopical Society of Canada (1978).

From 9. international congress on electron microscopy; Toronto, Ontario, Canada (1978).

A side-entry type, helium-temperature specimen stage that has the capability of in-situ electrical-resistivity measurements has been designed and developed for use in the AEI-EM7 1200-kV electron microscope at Argonne National Laboratory. The electrical-resistivity measurements complement the high-voltage electron microscope (HVEM) to yield a unique opportunity to investigate defect production in metals by electron irradiation over a wide range of defect concentrations. A flow cryostat that uses helium gas as a coolant is employed to attain and maintain any specified temperature between 10 and 300°K. This technique is being applied to the investigation of defect production in Ag. It is possible to make quantitative correlations between defect production involving isolated Frenkel pairs at low dose and clusters that form a higher dose. Ultimately, the technique will be used to measure the anisotropy of the displacement threshold energy and make a quantitative investigation of Bloch Wave Channelling.

12180 **Determination of lattice distortions around impurities by the polarized neutron method.** Cable, J.W.; Parra, R.E.; Child, H.R. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Solid State Commun.;* **27**: 911-913(1978).

Diffuse scattering measurements on a Pd-1 at.% Gd alloy are used to illustrate the polarized neutron method for the study of static lattice distortions in dilute alloys. The observed displacements are in semiquantitative agreement with theoretical values.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 11872, 12192, 12205

12181 (CONF-7909109—1) **Effects of hydrostatic pressure on the changes in elastic constants caused by hydrogen in vanadium and $Nb_{53}Ta_{47}$.** Fisher, E.S.; Alberts, H.L.; Katahara, K. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 5p. Dep. NTIS, PC A02/MF A01.

From Ultrasonics Symposium; New Orleans, LA, USA (26 Sep 1979).

Hydrogen dissolved in V, Nb or Ta or their solid solutions causes the C′ shear modulus to decrease, whereas C_{44} increases. These appear to be entirely different effects, with ΔC′ being a result of interstitial relaxation and ΔC_{44} arising from the electronic contribution. The apparent inverse dependence of ΔC′, i.e., relaxation strength, on atomic volume of the alloys implies that the positive hydrostatic pressure derivative of C′ should decrease with addition of H. This prediction has been tested with duplicate measurements at ANL and at HIG on two different vanadium samples with measure-

ments of C', C_{44} and K (bulk modulus) to 3kb. The results show dC'/dP decreasing significantly by 8% and 6.5%, respectively at HIG and ANL, with no significant changes in dC_{44}/dP or dK/dP. A second experiment on the alloy $Nb_{53}Ta_{47}$ showed dC'/dP decreasing by 10% with addition of 4.4 at. % H, with no changes in dC_{44}/dP or dK/dP.

12182 (COO—2872-04) **Hydrogen attack of steel. Progress report, April 1, 1979-March 31, 1980.** Shewmon, P.G. (Ohio State Univ., Columbus (USA). Dept. of Metallurgical Engineering). 2 Jan 1980. Contract EY-76-S-02-2872. 9p. Dep. NTIS, PC A02/MF A01.

The objective of this work is to establish the atomic processes by which the hydrogen attack of pressure vessel steel occurs. The approach is to follow the growth kinetics using an exceptionally sensitive dilatometer and to compare these data with the predictions of models based on the postulated mechanisms. This is supplemented by scanning electron microscope (SEM) studies to establish the geometry and location of the growing methane bubbles. The steels used have been various commercial alloys because of our now confirmed suspicion that trace impurities, e.g., from dioxidation practice, play a central role in determining the nucleation and growth geometry of the bubbles or fissures.

12183 (EPRI-AF—1176) **Metastable phenomena in hydrogen degradation of low carbon alloy steels. Interim report, December 1977 to November 1978.** Darken, L.S.; Ryba, E.R. (Pennsylvania Univ., Philadelphia (USA). Dept. of Metallurgy and Material Science). Sep 1979. 39p. Dep. NTIS, PC A03/MF A01.

According to thermodynamic calculations, the inclusion of chromium and other strong carbide-forming elements in steels should significantly lower the activity of carbon so that methane does not form in hydrogen atmospheres at moderate temperatures. However, degradation of low alloy steels does occur, and it is suggested that a metastable equilibrium condition exists in which the carbon atoms cluster around the atoms of the alloying elements in the ferrite phase and assume a higher activity. This suggestion has now been substantiated by the results of carbonization experiments in which pure iron and iron-chromium alloys have been exposed to atmospheres of varying carbon activities at 600° and 700°C. Measurement of weight changes by thermogravimetry has clearly shown that the solubility of carbon in the alloy ferrite is in excess of that in pure iron.

12184 (GA-A—15572) **Creep-rupture behavior of 2-1/4 Cr-1 Mo steel, Alloy 800H and Hastelloy Alloy X in a simulated HTGR helium environment.** Lai, G.Y.; Wolwowicz, R.J. (General Atomic Co., San Diego, CA (USA)). Dec 1979. Contract AT03-76ET35300. 75p. Dep. NTIS, PC A04/MF A01.

Creep-rupture testing was conducted on 1 1/4 Cr-1 Mo steel, Alloy 800H and Hastelloy Alloy X in flowing helium containing nominal concentration of following gases: 1500 μatm H_2, 450 μatm CO, 50 μatm CH_4, 50 μatm H_2O and 5 μatm CO_2. This environment is believed to represent maximum permissible levels of impurities in the primary coolant for the steam-cycle system of a high-temperature gas-cooled reactor (HTGR) when it is operating continuously with a water and/or steam leak at technical specification limits. Two or three heats of material for each alloy were investigated. Tests were conducted at 482°C and 760°C (1200°F and 1400°F) for Alloy 800H, and at 760°C and 871°C (1400°F and 1600°F) for Hastelloy Alloy X for times up to 10,000 h. Selected tests were performed on same heat of material in both air and helium environments to make a direct comparison of creep-rupture behaviors between two environments. Metallurgical evaluation was performed on selected post test specimens with respect to gas-metal interactions which included oxidation, carburization and/or decarburization. Correlation between gaseous corrosion and creep-rupture behavior was attempted. Limited tests were also performed to investigate the specimen size effects on creep-rupture behavior in the helium environment.

12185 (ISM—249) **Hydrogen embrittlement in vanadium single crystals.** Shei, S.; Scott, T.E. (Ames Lab., IA (USA)). 1979. Contract W-7405-ENG-82. 4p. (CONF-791132—2). Dep. NTIS, PC A02/MF A01.

From 2. JIM international symposium on hydrogen in metals; Minakami Spa, Japan (26 Nov 1979).

Mechanical properties of <149> oriented single crystals of high purity vanadium and hydrogen-charged vanadium were investigated in the temperature range from 77 to 296°K. Cleavage fracture occurred in hydrogen-charged crystals tested at temperatures above and below the stress-free hydrogen solvus temperature. Fractographic studies showed small whiskers along edges of cleavage steps. The effect of hydrogen on fracture behaviors and strengthening of vanadium is discussed.

12186 **Light ion irradiation creep apparatus.** Hendrick, P.L. (Pacific Northwest Laboratory, Richland, WA, USA). *Nucl. Instrum. Methods;* **161**: No. 3, 345-359(15 May 1979).

An experimental technique developed to measure the irradiation creep of metallic specimens subjected to light ion bombardment is described. The experimental apparatus has the capability to remotely set and control ion flux, stress and temperature. Specimen strain is measured continuously with a noncontracting laser extensometer developed for this application. A typical result obtained for the 17 MeV deuteron irradiation of a 0.15 mm (0.006 in.) thick nickel specimen is presented with an analysis of the source and magnitude of both systematic and random errors.

12187 **Nb_3Sn in 1978: state of the art.** Fietz, W.A. (Oak Ridge Natl Lab, Tenn). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 67-75(Jan 1979).

The current status of Nb_3Sn is reviewed from a user's point of view, with particular emphasis on the multifilamentary form of Nb_3Sn. Data from national laboratories, universities, and conductor manufacturers have been compiled and assessed. The result is a comprehensive picture of past, present, and future conductor types and their properties. Applications of these conductors in magnets are reviewed including devices already completed and those which are being proposed and/or constructed at this time. A summary of research and development programs in progress is included along with the author's assessment of their impact on future Nb_3Sn magnets. 121 refs.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 11864, 12179, 12206

12188 (SAND—79-1717C) **Thermal expansion of nickel to 2300°K.** Drotning, W.D. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 20p. (CONF-791134—5). Dep. NTIS, PC A02/MF A01.

From 16. international thermal conductivity conference; Chicago, IL, USA (7 Nov 1979).

The thermal expansion of nickel was measured from ambient to 2300°K using the gamma attenuation technique. The high temperature measurement system uses a high-vacuum tungsten mesh furnace designed for passage of a collimated gamma beam through the sample region. The gamma counting system incorporates a thermostatically-controlled detector and automatic gain control to achieve count rate stability. A precision analysis is given for the use of the technique to measure changes in molten density as a function of temperature, and a discussion of possible systematic errors in the use of the measurement technique is presented. The linear thermal expansion of solid nickel from ambient to the melting point (1728°K) was observed to be slightly larger than provisional values suggested in the literature. The thermal expansion of molten nickel was measured from melt to 2300°K. The volumetric expansion coefficient was found to be -(7.35 +- 0.09) x 10^{-4} g/cm³ °K over this temperature range, which is compared with measurements by previous investigations which range from -6.4 to -12.1 x 10^{-4} g/cm³ °K.

12189 (UCRL—52828) **Electrical discharge in gases: a technique for detecting metal anomalies.** Lord, D.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Jun 1979. Contract W-7405-ENG-48. 23p. Dep. NTIS, PC A02/MF A01.

Optical ionization effects in gases appear to be very sensitive indicators of nonuniformities caused by contamination, deformation, and other factors affecting a metal surface. These optical effects are influenced by surface electron emission, which is influenced in turn by the chemical, metallurgical, and mechanical condition of the metal surface. Based on these effects, a general technique for inspection of critical parts that is fast, inexpensive, nondestructive, and not limited by size or geometry is presented. Ionization effects that reveal nonuniformities and were recorded with standard photographic equipment are shown.

12190 (UCRL-Trans—11518) **Influence of silicon on the diffusion of gold in germanium.** Belokurova, I.N.; Zemokhov, V.S.; Klochko, V.A. Oct 1979. Translated from Issled. Mater. Nov. Tekh. Dokl. Nauchno-Tekh. Konf., 1969, pp 113-118 (1971). 8p. Dep. NTIS, PC A02/MF A01.

The diffusion of gold in solid solutions of germanium with Si contents ranging from 0 to 4.5 at. % was determined. The pn junction method was used. (FS)

12191 **Reduction of void-volume fraction in Nb by Ti alloying.** Loomis, B.A.; Gerber, S.B. (Argonne National Lab., IL (USA)). *J. Nucl. Mater.;* **80**: No. 2, 383-385(May 1979).

It has been shown previously by the authors (see ibid. vol. 73, p. 58, 1978) that the void-volume fraction in Nb is reduced at least one order of magnitude by a 0.16 μm thick Ti coating on 3.2 MeV Ni^+ irradiation. In the present work the reduction of void-volume fraction in ion-irradiated Nb by alloying with 2, 4, 18 and 25 at% Ti, is reported.

12192 **Stress effects on multifilamentary Nb_3Sn wire.** Bartlett, R.J.; Taylor, R.D.; Thompson, J.D. (Los Alamos Sci Lab, NM). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 193-196(Jan 1979).

Critical current I/sub c/ measurements were obtained on highly stabilized mf Nb_3Sn wires as a function of heat treatment, stress, temperature, and applied magnetic field. The ratio of the area of the copper to bronze core-niobium tube is about 8, and the filaments are concentrated in the inner 30% of the wire cross section. Values of I/sub c/ and T/sub c/ were determined for samples subjected to a wide range of heat treatments. Diffusion reaction times and temperatures in the ranges 16 to 128 hr and 700 to 750°C provided a number of mf Nb_3Sn wires having similar I/sub c/ characteristics. To some extent the residual compressive loading on the Nb_3Sn wires varied with the particular heat treatment. This loading arises primarily from the differential contraction of the remaining bronze and the Nb_3Sn layer when cooled from the reaction temperature to the operating temperature. It was found that, by controlled bending or stretching of the wires, whereby some of the strain in the Nb_3Sn is relieved, the I/sub c/ at 14 K is increased by as much as 30% and the critical temperature is increased by up to 1 K.

12193 Asymmetry of normal zone propagation velocity with respect to current in a multifilamentary composite superconductor. Bartlett, R.J.; Carlson, R.V.; Overton, W.C. Jr. (Los Alamos Sci Lab, NM). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 343-346(Jan 1979).

The phenomenon of destruction of superconductivity by current in a high current multifilamentary composite superconductor was observed. This bronze-stabilized conductor had rectangular dimensions of 0.56 cmx0.17 cm, contained 67,507 Nb_3Sn filaments of about 5.8-μm diam and had a self-field critical current at 0 K of about 6.1 kA. The velocity of normal zone propagation was measured on a 56-cm-long sample of this conductor in a vacuum environment. Currents ranged from 200 A to 900 A and initial sample temperatures ranged from 14.5 K to 16 K. A significant dependence of the velocity on the direction of the current was noted. Because there is essentially zero heat transfer into a surrounding environment, the effect must relate to an asymmetry of the fundamental interactions between current and heat flow in the filaments.

12194 Experimental and theoretical study of the effect of local heating on composite superconductors. Schermer, R.I. (Univ of Calif, Los Alamos Sci Lab, NM). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 355-358(Jan 1979).

Experiments have been performed where a short section of long, stabilized, NbTi conductor was driven normal and the voltage was recorded as a function of position and time. Conductors tested included samples with internal cooling channels or electrically insulating coatings. Heater power or pulse energy, conductor current, and background magnetic field were varied. The data show a number of interesting effects not previously noted in experiments where the entire conductor length was heated. These effects are discussed, as are comparisons of steady-state results with predictions of numerical computations. In general, the computation accurately predicts the power required to form a normal zone as a function of field and current. Both experiment and theory show that the temperature interval bracketing the nucleate-to-film-boiling discontinuity in the heat transfer coefficient can be traversed smoothly without any corresponding discontinuity in the curve of maximum wire temperature vs heater power. The normal zone is hotter and longer than predicted, however, modifications to previously published results for apparent heat transfer in the film boiling regime are thus necessary.

12195 High magnetic field properties of CVD-prepared Nb_3Ge and $Nb_3(Ge,X^+)$). Thompson, J.D.; Maley, M.P.; Newkirk, L.R.; Carlson, R.V. (Los Alamos Sci Lab, NM). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 516-519(Jan 1979).

Measurements of the field-dependent critical current density, J/sub c/(H), and the upper critical field, H/sub c2/, have been performed on a number of Nb_3Ge samples prepared by the chemical vapor deposition (CVD) process. These samples, obtained from up to 20 lengths of Nb_3Ge tape, were deposited on various substrates at temperatures between 835 and 950°C. Flux pinning, provided by the introduction of controlled amounts of second phase precipitate, Nb_5Ge_3, produced good high-field properties with 4.2 K critical current densities on the order of 8.3×10^4 A/cm² at 18 T. Measurements of J/sub c/(H) performed on these samples in both liquid helium and hydrogen in fields up to 18.5T have been analyzed in terms of E.J. Kramer's model of flux pinning. Qualitative agreement has been found with the scaling laws predicted by this theory. The effect of ternary additions of Si and Ga on both H/sub c2/ and J/sub c/(H) have been investigated as well. Contrary to expectation, the addition of ternaries into the A-15 lattice results in somewhat depressed critical characteristics. The effect of deposition parameters on the high field properties of both Nb_3Ge and $Nb_3(Ge,X)$ is discussed.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 11052, 11185, 11332, 11333, 11356, 11878, 11889, 12184

12196 (CONF-781093—4) Effects of particle size and shape on erosive wear mechanisms. Kosel, T.H.; Turner, A.P.L.; Scattergood, R.O. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 18p. Dep. NTIS, PC A02/MF A01.

From TMS/AIME fall meeting; St Louis, MO, USA (15 Oct 1978).

Scanning and transmission electron microscopy (SEM and TEM) were used to examine mechanisms of erosion of pure fcc metals by angular Al_2O_3 particles and spherical glass microbeads. The depth of the subsurface dislocation damage was found by TEM to be greater for spherical particles than for angular ones. Higher angles of impact produce thicker layers of damage. Erosion with Al_2O_3 particles was observed to result in embedding of Al_2O_3 particle fragments for all angles of impact and velocities. For normal impact the Al_2O_3 particle fragments cover most of the specimen surface, and for certain particle sizes and velocities the entire surface is covered with a composite layer of Al_2O_3 fragments mixed with the specimen metal. Erosion mechanisms under such conditions are discussed. Incubation periods of the true erosion rate (after allowance for embedding effects) are observed for glass microbeads and also for larger Al_2O_3 particles. This is probably due to gradual damage accumulation.

12197 (COO—2354-6) Cluster carburizing. Final report, June 1, 1973-May 31, 1979. Morral, J.E. (Connecticut Univ., Storrs (USA)). May 1979. Contract EY-76-S-02-2354. 10p. Dep. NTIS, PC A02/MF A01.

Three major accomplishments of the cluster carburizing program were showing that the hardness of aged and carburized materials could be controlled via the aged structure; developing a new and analytical theory of subscale formation; and characterizing the properties of Ta-Hf alloys with respect to precipitation kinetics and morphology, diffusion kinetics, age hardening, and subscale formation. The first of these verified the cluster carburizing concept, which has potential use in the development of high strength materials. The second has applications in the fields of hot corrosion, oxidation, and high temperature coatings. The third provided necessary background for this study and provided a further understanding of the behavior of refractory metals. Details about the above are contained in this final report as well as comments on the Ta-Hf, TaC-HfC and NbC-HfC phase diagrams, a comparison of hardening in the Nb-Hf and Ta-Hf system, and a discussion of possible future work.

12198 (LBL—10110) Effects of the microstructure of ductile alloys on solid particle erosion behavior. Levy, A.V.; Jahanmir, S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; Cornell Univ., Ithaca, NY (USA)). Oct 1978. Contract W-7405-ENG-48. 15p. (CONF-781093—5). Dep. NTIS, PC A02/MF A01.

From TMS/AIME fall meeting; St Louis, MO, USA (15 Oct 1978).

The effect of microstructure of two phase alloys, consisting of a softer, ductile matrix and a harder interspersed phase, on erosion behavior was determined. The stress and strain distribution in a two phase alloy where the second, hard phase is a distribution of particles in a more ductile matrix was calculated. It was determined that a spheroidized 1075 carbon steel eroded 30 percent less than a pearlitic microstructure of the same steel even though the spherodized form was 21 R/sub B/ points of hardness lower than that of the pearlitic steel. The computerized calculation of stresses and strains from the impact of eroding particles on a two phase alloy surface were used to define the ability of the particle impact to induce voids and cracks in the target material that could cause material loss. The resultant predicted voids and cracks were related to experimentally determined behavior of spherodized steel.

12199 Validity of electrochemical methods for measuring corrosion rates of copper-nickel alloys in sea water. Syrett, B.C.; MacDonald, D.D. (Stanford Research Inst., Menlo Park, CA). *Corrosion;* **35**: No. 11, 505-509(Nov 1979).

This work was stimulated by reports that electrochemical methods for measuring the polarization resistance of copper, nickel, or copper-nickel alloys in aqueous systems may lead to appreciable errors in the estimates of the corrosion rate. In the present work, the polarization resistance (R/sub p/) of two copper-nickel alloys (90:10 Cu:Ni and 70:30 Cu:Ni) was monitored as a function of time in flowing sea water that contained 0.045,0.85, 6.6, or 26.3 mg/dm³ dissolved oxygen. R/sub p/ values were obtained using the linear polarization, potential step, and AC impedance techniques. The total weight loss during the test period was calculated from the area under the 1/R/sub p/ versus time curve and compared with the measured weight loss. The experimental data support the validity of electrochemical methods for measuring corrosion rates of copper-nickel alloys in sea water, provided that a sufficient number of R/sub p/ measurements are made during the first 24 hours, and provided that proper consideration is given to the capacitive elements of the metal/solution interfacial impedance. Previous reports that electrochemical measurements may lead to underestimates of the corrosion rates are thought to have resulted primarily from undetected (and

very high) corrosion rates at short exposure times. Reported overestimates of the corrosion rates are thought to have resulted from the use of a potential sweep rate that was too high (linear polarization technique), a time for current decay that was too short (potential step technique), or excitation frequencies that were insufficiently low (AC impedance technique).

12200 Corrosion by alternating current: a study of the anodic polarization of mild steel in Na_2SO_4 solution. Chin, D.T.; Fu, T.W. (Clarkson Coll. of Tech., Potsdam, NY). *Corrosion;* **35**: No. 11, 514-523(Nov 1979).

A study has been made of the anodic polarization of mild steel in Na_2SO_4 solutions (pH 3-9) in the presence of a sinusoidal electric current. The measurement was carried out over a range of alternating current (ac) densities from 0 to 200 mA/cm^2 and ac frequencies from 20 to 6000 Hz. It was found that the corrosion potential of mild steel shifted toward the active direction in the presence of ac. The magnitude of the potential shift increased with increasing ac densities, and decreased with ac frequencies. ac also increased the passivity current density in a way similar to the addition of chloride ions to the electrolyte. The phenomenon was explained with a time-averaging analysis of the mixed potential theory.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 12186

12201 (COO—3158-81) **Direct determination of radiation damage profiles in the order-disorder alloys Ni_4Mo and Pt_3Co irradiated with 500 to 2500 eV Ne^+ ions.** Aidelberg, J. (Cornell Univ., Ithaca, NY (USA). Materials Science Center). Oct 1979. Contract EY-76-S-02-3158. 221p. Dep. NTIS, PC A10/MF A01.

Radiation damage produced in the order-disorder alloys Ni_4Mo and Pt_3Co by low-energy (500-2500 eV) Ne^+ ions has been observed directly, on an atomic scale, employing the field-ion microscope (FIM) technique. A new approach was developed to determine the radiation damage distribution in these alloys. In the case of the alloy Ni_4Mo the measurements were based on the contrast differences between the FIM images of an ordered alloy, which were completely regular, and a disordered alloy which appeared as a random array of image points. FIM specimens of the ordered alloy Ni_4Mo were irradiated in situ at 30°K, and the side of the specimen exposed to the beam became disordered as a result of the implantation of the neon atoms. The change from an ordered state to a disordered state was detected by the controlled dissection of the specimen, on an atom-by-atom basis, employing the pulse field-evaporation technique. The amount of disordered metal, which was field-evaporated, to expose the perfectly ordered lattice, and some basic geometric relations gave the depth of radiation damage: the depth resolution was $\simeq$ 2 A. A crystallographic directional dependence of the mean depth of radiation damage (anti x/sub d/) was observed and was attributed to the effect of channeling. For the non-channeling direction the value of anti x/sub d/ varied from $\simeq$ 6 to $\simeq$ 19 A as the irradiation energy was increased from 500 to 2000 eV. The experimental anti x/sub d/ versus Ne^+ ion energy relation agreed with the theoretical predictions of Winterbon, Sigmund and Sanders, and the results of the Monte Carlo computer simulation program, of Biersack and Haggmark, called TRIM.

12202 Extended low-temperature annealing of neutron-irradiated molybdenum. Kissinger, H.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). *Radiat. Eff. Lett.;* **43**: No. 3, 75-78(Jun 1979).

Isothermal resistance recovery experiments have been performed on neutron-irradiated molybdenum at temperatures from 89°C to 198°C for time periods exceeding 30 weeks. The final portion of the observed recovery is linear with the logarithm of time and can be described mathematically as a zero-order reaction with a variable activation energy. This additional recovery leads to an error in recovery end-point determination and may be responsible for the anomalous values of reaction order reported for recovery at these temperatures.

12203 Irradiation effects in magnesium and aluminium alloys. Sturcken, E.F. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). *J. Nucl. Mater.;* **82**: No. 1, 39-53(Jun 1979).

Effects of neutron irradiation on microstructure, mechanical properties and swelling of several magnesium and aluminium alloys were studied. The neutron fluences of 2 to 3 x 10^{22} n/cm^2, >0.2 MeV produced displacement doses of 20 to 45 displacements per atom (dpa). Ductility of the magnesium alloys was severely reduced by irradiation induced recrystallization and precipitation of various forms. Precipitation of transmuted silicon occurred in the aluminium alloys. However, the effect on ductility was much less than for the magnesium alloys. The magnesium and aluminium alloys had excellent resistance to swelling: The best magnesium alloy was Mg/3.0 wt% Al/0.19 wt% Ca; its density decreased by only 0.13%. The best aluminium alloy was 6063, with a density decrease of 0.22%.

12204 Technique for determining the depth distribution of cavities in He^+-irradiated nickel. Fenske, G.; Das, S.K.; Kaminsky, M. (Argonne National Lab., IL (USA)). *J. Nucl. Mater.;* **80**: No. 2, 373-378(May 1979).

The authors describe a technique for examining the depth distribution of the damage (i.e., dislocations, bubbles and voids) in $^4He^+$ ion-irradiated nickel. One existing technique is to section the sample parallel to the direction of the incident beam and prepare thin foils suitable for TEM. This technique has been used only in a few instances because of the difficulty in sample preparation, but it has the advantage that the entire depth distribution of damage can be obtained from a single sample. The technique described by the present authors is a modification of this type of technique and allows one to observe the depth distribution of bubbles and of damage in very near surface regions (<0.2μm) with excellent depth resolution and a small (approximately 50 A) uncertainty in locating the irradiated surface.

12205 Irradiation creep by climb-enables glide of dislocations resulting from preferred absorption of point defects. Mansur, L.K. (Oak Ridge National Lab., TN (USA)). *Philos. Mag., A;* **39**: No. 4, 497-506(Apr 1979).

A mechanism of irradiation creep arising from the climb-enabled glide of dislocations due to stress-induced preferred absorption of radiation-produced point defects is proposed. This creep component is here termed preferred absorption glide, PAG. PAG-creep operates in addition to the previously studied components of creep from climb by stress-induced preferred absorption, (SI) PA-creep, and the climb-enabled glide due to excess absorption of interstitials on dislocations during swelling, I-creep. A formulation of the various climb and climb-enabled glide processes which includes earlier results is presented. PAG-creep is comparable in magnitude to PA-creep in the parameter range of applications. While the PSA-creep rate and the I-creep rate are linear in stress, the PAG-creep rate is quadratic in stress and thus dominates at high stresses.

12206 Neutron-irradiation effects in the pseudobinary compound $Nb_3(SnGa)$: changes in T/sub c/, I/sub c/, and flux pinning. Snead, C.L. Jr.; Suenaga, M. (Brookhaven Natl Lab, Upton, NY). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 625-628(Jan 1979).

Specimens of single-core wires of $Nb_3(SnGa)$ have been neutron irradiated at approximately 100°C to fluences of 2.6x10^{19} n/cm^2 (E>1.0 MeV). Measurements of I/sub c/ at 4.2 K in transverse magnetic fields to 22 T and measurements of T/sub c/ were made. The interest in this material (approximately lat.%Ga in the Nb_3Sn layer made by the "bronze process") stems from the greater values of critical properties (T/sub c/=17.4 K, H/sub c2/approximately equals 22.5 T) relative to those of Nb_3Sn. Results are given for two different specimen reaction temperatures, 700 and 750;degree;C. Increases in I;sub c; for low-fluence (<3x10^{18} n/cm^2) irradiations similar to those observed for Nb_3Sn were observed, but with greater relative increases for the specimens (750°C) that had the lower initial current density. Decreases in I/sub c/ at higher fluences scaled with the measured decreases in T/sub c/ similar to behavior of Nb_3Sn. Increases in H/sub c2/ of the lower-temperature-reacted specimens were much smaller than those observed in Nb_3Sn in Nb;sub 3;Sn. In the higher-temperature-reacted specimens, the lack of any H/sub c2/ increases at all suggests that some kind of limiting mechanism is active. For neutron fluences above approximately equals5x10^{18} n/cm^2 the limiting of H/sub c2/ is not in evidence.

CERAMICS, CERMETS, AND REFRACTORIES

REFER ALSO TO CITATION(S) 11063

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 11311, 11314

12207 Synthesis and characterization of zirconia electrolytes for potential use in energy conversion systems. Wheat, T.A. Ottawa, Ontario; Minister of Supply and Services Canada (1979). 36p. (CANMET—79-2). Canmet Publication Office, Ottawa, Ontario.

Using a wet-chemical procedure, a series of compositions having between 0 and 22.2 mol % CaO was prepared and subsequently formed into sintered samples having a relative density from 95 to 98%. Sintered samples were prepared of each composition with a geometry appropriate for determining the thermal, electrical or microstructural characteristics. The microstructural aspects of powder synthesis and the development of sintered materials are covered.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 12197, 12207

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 12062, 12067

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 11187, 12061, 12062, 12197

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 11884

12208 Irradiation-induced densification and PuO_2 particle behavior in mixed-oxide pellet fuel. Freshley, M.D.; Brite, D.W.; Daniel, J.L.; Hart, P.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). *J. Nucl. Mater.;* **81**: No. 1-2, 63-92(Apr 1979).

The in-reactor densification characteristics of mixed-oxide fuels and the extent of thermal and irradiation-induced U, Pu homogenization in mechanically blended, mixed-oxides for thermal reactors were investigated. These results are compared with the behaviour of UO_2 fuels irradiated under similar conditions. There are many similarities in the densification behaviour of mixed-oxide and UO_2 fuel types. Mixed-oxide fuel densification was not sensitive to plutonia concentration up to 6 wt% or PuO_2 particle size covering a range from effectively zero to 500 μm dia. As in UO_2 fuels, the densification behaviour of the mixed-oxide, fuel types is related to microstructural features such as grain size and pore size and can be predicted by behaviour during out-of-reactor isothermal resintering tests. Significant PuO_2 homogenization can occur during irradiation to relatively low burnups at fuel temperatures greater than about 1520°C. It was also shown that significant irradiation-induced PuO_2 homogenization occurred at fuel temperatures as low as about 520°C at a fission rate of 6 x 10^{12} f/cm^3-sec.

POLYMERS AND PLASTICS

STRUCTURE AND PHASE STUDIES

12209 Dynamic study of the crystallization of polyethylene from the melt. Schultz, J.M. (Univ. of Delaware, Newark); Lin, J.S.; Hendricks, R.W. Contract W-7405-ENG-26. *J. Appl. Crystallogr.;* **11**: 551-557(1978).

Crystallization of a linear polyethylene from the melt was followed in situ with the ORNL 10-meter SAXS camera. Specimens were rapidly cooled in the x-ray beam in tandem birdcage furnaces from ~ 180°C to temperatures between 115 and 126°C, and scattering patterns were recorded for 30 s in 50 s intervals. Because of this relatively high-speed data acquisition rate, it was possible to obtain data in time periods which were short compared to the rate of change of the scattering patterns. The SAXS curves showed shapes which changed continuously during crystallization. The scattering curves are the superposition of a zero-angle peak and a Bragg maximum. Guinier plots of the zero-angle peak manifest scattering by lamellae of constant thickness. The thickness value is nearly that expected for crystallites at these crystallization temperatures. A model in which skeletal spherulites form and then later fill in is consistent with these results. Decreasing SAXS intensity and changing Bragg peak intensities indicate crystal thickening during cooling to room temperature. 8 figures.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 11632, 11739

12210 (UCRL—82862) **Stress-rupture lifetimes of organic fiber-epoxy strands and pressure vessels.** Hahn, H.T.; Chiu, I.L.; Gates, T.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Aug 1979. Contract W-7405-ENG-48. 25p. (CONF-800203—1). Dep. NTIS, PC A02/MF A01.

From 35. annual conference of the SPI reinforced plastics/composites institute; New Orleans, LA, USA (4 Feb 1980).

Long-term behavior of filament-wound pressure vessels were tested, Kevlar 49 epoxy strands were studied in stress-rupture for more than a year. Because the strands are the smallest structural unit in filament winding, their behavior directly controls the performance of vessels. Five different stress levels were studied: 86, 80, 74, 68, and 50% of the mean ultimate tensile strength (UTS). At each stress level, approximately one-hundred strands were hung in a room maintained at 22 to 24°C and below 20% relative humidity. Failure times were automatically recorded by a data acquisition system. Lifetimes were analyzed statistically using a two-parameter Weibull distribution. The maximum-likelihood method was used to estimate the parameters. The shape parameter, which is a measure of scatter and failure-rate change, increased with decreasing stress level. Less scatter and increasing failure rates were observed at lower stresses. There was no sign of an endurance limit down to 68% UTS. At 50% UTS no failure had yet occurred after 9000 h. The strand data were compared with data on lifetimes of pressure vessels wound with the same fiber and epoxy. The strands had slightly longer characteristic lifetimes, except at 86% UTS, and slightly less scatter, except at 68% UTS. The results of this study indicate that strands can provide valuable information about the long-term performance of filament-wound pressure vessels.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 11686, 11739, 12668

OTHER MATERIALS

REFER ALSO TO CITATION(S) 12668

12211 (NTIS/PS—79/0667) **Activated carbon. Volume 2. 1975-June, 1979 (citations from the NTIS data base). Report for 1975-Jun 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Jul 1979. 282p. NTIS PCN01/MF N01.

The bibliography of Federally-funded research cites reports on sewage and industrial waste water treatment using activated carbon. These have been separated from other uses of activated carbon. The first part contains both laboratory as well as engineering studies. The second part covers other reports on activated carbon including research on its properties and its use in air pollution control, gas and water analysis, the absorption of chemicals and radioactive isotopes especially iodine isotopes, and drinking water treatment. (This updated bibliography contains 271 abstracts, 42 of which are new entries to the previous edition.)

12212 (NTIS/PS—79/0668) **Activated. Volume 2. 1arbon. Part 1. Waste water treatment. Volume 2. 1976-june, 1979. (citations from the engineering index data base). Report for 1976-Jun 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Jul 1979. 224p. NTIS PCN01/MF N01.

These citations from a worldwide literature survey cover activated carbon as it is used in treating industrial and sewage wastes, relative to process description, economics, mathematical models, performance, and the property changes the carbon undergoes. (This updated bibliography contains 218 abstracts, 62 of which are new entries to the previous edition.)

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 11439, 11441, 11442, 11443, 11445, 11450, 11459, 11460, 11465, 11466, 11469, 11470, 11471, 11472, 11478, 11479, 11480, 11482, 11485, 11486, 11496, 11498, 11500, 11501, 11508, 11509, 11525, 11526, 11527, 11528, 11529, 11530, 11531, 11532, 11544, 11545, 11547, 11554, 11556, 11557, 11559, 11585

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 11483, 11484, 11558, 12215

PROPERTIES

REFER ALSO TO CITATION(S) 11439, 11441, 11472, 11481, 11496, 11502, 11523, 11904

12213 (ORNL/TM—7173) **High voltage research (breakdown strengths of gaseous and liquid insulators) and environmental effects of dielectric gases. Semiannual report, April 1, 1979-September 30, 1979.** Christophorou, L.G.; James, D.R.; Pai, R.Y.; Mathis, R.A.; Sauers, I.; Frees, L.; Pace, M.O.; Bouldin, D.W.; Chan, C.C. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 128p. Dep. NTIS, PC A04/MF A01.

A number of gas mixtures are suggested for industrial-scale testing. Electron attachment rates were measured and unfolded to give attachment cross section functions for CCl_3F, CCl_2F_2, and $CClF_3$ each in N_2, and for CCl_3F in Ar. Electron attachment rates were measured also for n-C_6F_{14} in both Ar and N_2. The effects of molecular structure on energy, cross section, and lifetime of negative ion states of organic molecules were considered. A study was made of the potential role of electron detachment in breakdown. The role of dipolar scattering of electrons in inhibiting breakdown was investigated. The nature of synergisms among constituents of a gas dielectric mixture is discussed. Examples are cited from recent breakdown measurements. Breakdown measurements in plane-plane geometry were made for CF_4, 1,1,1-CH_3CF_3, and CHF_3. Similar measurements were conducted with binary mixtures containing one of (c-C_4F_8, SF_6) and one of (CF_4, CH_2F_2, 1,1,1-CH_3CF_3, CH_2F_2). Of special interest in these results were observed synergisms and the effect of dipole moment on the breakdown strengths. The initial fragmentation of 1,1,2-$C_2Cl_3F_3$ under electron impact was studied.

Final decomposition products of sparked SF_6/2-C_4F_8 mixtures were identified and quantified. The breakdown products of SF_6 were studied. Impulse measurements concentrated on c-C_4F_8/SF_6 mixtures. Values of V_{50}, V/sub NO/, and V/sub 10x/ were obtained and evaluated. In the practical conditions of cylindrical geometry with and without surface roughness, many multicomponent mixtures of the gases SF_6, c-C_4F_8, 2-C_4F_8, N_2, and 1,1,1-CH_3CF_3 were tested, at both 1 and 4.4 atmospheres. The electric fields were calculated. In the study of liquid dielectrics n-hexane and perfluoro-n-hexane were tested. 35 figures, 20 tables.

12214 (UCRL—15160) **Fracture and fragmentation of high energy propellant.** Murri, W.J.; Gupta, Y.M.; Curran, D.R. (SRI International, Menlo Park, CA (USA)). Apr 1979. Contract W-7405-ENG-48. 48p. Dep. NTIS, PC A03/MF A01.

Experimental and analytical studies on dynamic fracture and fragmentation of VRA high energy propellant are reported. The overall purpose is to develop a predictive model for fracture, and fragmentation, and associated formation of new surface area during dynamic loading. (FLS)

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 11884

12215 (LBL—9990) **Model of the recrystallization mechanism of amorphous silicon layers created by ion implantation.** Drosd, R.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 96p. Dep. NTIS, PC A05/MF A01.

Thesis.

The recrystallization behavior during annealing of thin films of amorphous (α) silicon, in contact with a single crystal silicon substrate (referred to as C), has been studied in the transmission electron microscope (TEM). The amorphous film is created during high dose phosphorus ion implantation at 100 keV. It was found that the crystal substrate orientation and the implantation temperature have dramatic effects on the recrystallizaton rate, and the defect microstructure produced during annealing. Specifically, (100) wafers implanted at 77°K contain only a low density of dislocation loops, but when the same wafer is implanted at room temperature the dislocation density is increased drastically. (111) wafers, when implanted at 77°K show a high density of microtwins, but as the implantation temperature is increased a gradual increase in the density of dislocation loops is observed along with a reduction of the microtwins. At an implantation temperature of about 100°C both orientations give an identical defect microstructure when annealed, which is a dense tangle of dislocations.

CHEMISTRY

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 11273, 11458

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 12425, 12477

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 12456

12216 (COO—4320-2) **Analytical chemical system for the determination of heavy metals and organic compounds. Annual progress report, December 1, 1978-November 30, 1979.** Siggia, S.; Barnes, R.M. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Chemistry). 24 Oct 1979. Contract EE-77-S-02-4320. 49p. Dep. NTIS, PC A03/MF A01.

Progress has been made in the synthesis and characterization of new resins for sequestering inorganic and organic compounds. The capabilities of the poly(dithiocarbamate) resin have been extended, a new poly(acrylamidoxime) resin prepared and characterized, and a series of resins for organic compounds prepared and tested. Limited actual sample analyses have been performed with these resins. A new inductively coupled plasma source, spectrometer, and computer system have been received and they are undergoing tests and installation. With this system in place, the multielement analysis of metals during the forthcoming period will insure the application of sequestering resins to practical analysis of energy-related materials. An automated sample handling and data system has been designed, some components purchased, and construction is scheduled for 1980.

12217 (Y—2193) **Determination of nitrogen and oxygen in uranium metal by inert-gas fusion.** Carden, W.F. (Oak Ridge Y-12 Plant, TN (USA)). Dec 1979. Contract W-7405-ENG-26. 19p. Dep. NTIS, PC A02/MF A01.

An improved analytical method has been developed using inert-gas fusion for determining the nitrogen and the oxygen contents of uranium metal. The analytical method is applicable to concentrations of nitrogen and oxygen ranging from 1 microgram per gram to 1000 micrograms per gram for each gas. In uranium metal, the limit of error for a single determination at the 95%-confidence level, at the 12-micrograms-per-gram-nitrogen level, is +-3 micrograms per gram nitrogen and, at the 20-micrograms-per-gram-oxygen level, is +-3 micrograms per gram oxygen. Nitrogen and oxygen concentrations are determined by using a nitrogen-oxygen determinator.

12218 (Y—2194) **Determination of hydrogen in uranium-niobium-zirconium alloy by inert-gas fusion.** Carden, W.F. (Oak Ridge Y-12 Plant, TN (USA)). Dec 1979. Contract W-7405-ENG-26. 18p. Dep. NTIS, PC A02/MF A01.

An improved method has been developed using inert-gas fusion for determining the hydrogen content in uranium-niobium-zirconium (U-7.5Nb-2.5Zr) alloy. The method is applicable to concentrations of hydrogen ranging from 1 to 250 micrograms per gram and may be adjusted for analysis of greater hydrogen concentrations. Hydrogen is determined using a hydrogen determinator. The limit of error for a single determination at the 95%-confidence level (at the 3.7-μg/g-hydrogen level) is +-1.4 micrograms per gram hydrogen.

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 11385, 12524, 12532

12219 (LBL—10097) **I. Conformational analysis of cyclic peptides. II. Multinuclear NMR spectrometer for the study of biological systems.** Shih, W.C.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 381p. Dep. NTIS, PC A17/MF A01.

Thesis.

A systematic approach to the employment of ^1H NMR data to the analysis of the solution conformations of small polypeptides is outlined. Two-dimensional homonuclear J-spectra along with the corresponding 45° projections and contour maps simplify the task of homonuclear decoupling experiments, and the assignments of lines is made very straightforward. The vicinal couplings that are likely to vary as the conformation changes are then examine. Spectrum simulations coupled with x-ray data for model systems allow the formulation of Karplus relationships for the vicinal couplings, and solution conformations may then by inferred. This approach to conformational analysis was applied to an examination of the metal affinities of two cyclopeptides. The NMR data revealed that the metal affinities of the two differ as a result of the different orientation of both carbonyl groups. Part II describes the design approach, major construction details, and the test characterization procedures associated with the construction of a broadband multinuclear NMR spectrometer system. The design emphasis was on incorporating features that would be useful for biological experiments. Summaries of original designs are included with schematic documentation.

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 11117, 11453, 12219, 12231, 12448, 12450, 12456, 12472, 12552, 12553

12220 (LA-UR—79-3238) **Top down viewing of the inductively coupled plasma using a dual grating, direct reading spectrograph and an all mirror optical system.** Apel, C.T.; Duchane, D.V.; Palmer, B.A. (Los Alamos Scientific Lab., NM (USA); Colorado School of Mines, Golden (USA). Dept. of Physics; Southwestern at Memphis, TN (USA). Dept. of Physics). 1980. Contract W-7405-ENG-36. 47p. (CONF-800110—1). Dep. NTIS, PC A03/MF A01.

From International conference on developments in atomic plasma spectrochemical analyses; San Juan, Puerto Rico (7 Jan 1980).

Using an all-mirror optical system, an inductively coupled plasma is viewed top down and the light is directed to a dual grating, direct reading spectrograph. Top down viewing of the plasma, with masking of the image of the argon plasma torus at the spectrograph entrance slit, significantly reduces background signal from the source and permits the use of the depth of field of the optical system to achieve compromise conditions for viewing the plasma. Light from the plasma source is introduced to the optical system by means of a mirror situated directly over the plasma. The system is exhausted in such a way that cool air flowing past the mirror forms a thermal barrier between the mirror and the plasma. Elements such as copper and lead have atomic and ionic lines which tend to exhibit self absorption when viewed top down through the cooler ground

state atoms in the plume of the plasma. One of the approaches to this problem is to shear off the plume of the plasma with a jet of air directed across the tip of the plasma. A second approach is to make use of the dual grating, direct reading spectrograph and real-time computer system which easily permits the setting of alternate lines for each element so that self absorption and matrix effects are minimized. The design of the dual-grating, direct-reading spectrograph allows for the mounting of more than 200 13-mm-dia photomultiplier tubes along the focal curves. In an effort to demonstrate the use of fiber optics as a viable technique for the closer placement of exit slits, a red sensitive photomultiplier tube was coupled with a 30-cm fiber-optic ribbon to detect light from the Li 670.784 nm line on the focal curve. It was successful and had the added advantages of absorbing second-order ultraviolet light.

12221 (UCRL-Trans—1587) **Succinic acid in wines.** Castino, M. Translated from *Vini d'Italia;* **11**: 509-521(1969). 22p. Dep. NTIS, PC A02/MF A01.

Following a brief discussion of methods which are currently employed to determine the succinic acid content of wines, as well as the shortcomings of those methods, procedures used for colorimetric evaluation of this particular acid are explained. The principal advantages offered by the proposed method are: elimination of interference produced by 2-ketoglutaric acid (which produces succinic acid when permanganate oxidation occurs), notable simplification of procedures, and a need for only a small quantity of wine. Application of the proposed method with pure solutions and with wines of various origins confirms its validity in terms of satisfactory accuracy of data. With table wines and special types of wines (sparkling wines and wines having an aromatic content), succinic acid levels were found to vary between 0.50 and 1.18 grams per liter.

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 11307, 11308, 11316, 11319

12222 (UCD—472-125, pp 168-169) **More sensitive method for liquid scintillation assay of ^{222}Rn in aqueous samples.** Parks, N.J. Oct 1979.

In Annual report, 1978-1979.

Experiments indicated that a variation of the isopiestic method from solution thermodynamics is a useful technique for conventional liquid scintillation detection of radon in water samples containing less than 1 fCi/cm^3. The isopiestic method removes the restriction imposed by the counting-vial volume on the maximum volume of water which can be assayed.

12223 **Separation of trivalent actinides from lanthanides by solvent extraction.** Kasting, G.B.; Hulet, E.K.; Heppert, J.A.; Wild, J.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *J. Inorg. Nucl. Chem.;* **41**: No. 5, 745-747(1979).

A method is presented for separating the trivalent actinides, mainly Am and Cm, from trivalent lanthanides by the use of only two solvent extractants. The first solvent removes the heavy lanthanides, leaving the Am, Cm and the lighter lanthanides; the second removes the Am and Cm. Because additional complexing agents are not required, waste-disposal and corrosion problems are reduced. Overall separation factors may be as high as several thousand for the separation of Am and Cm from lanthanides in the fission waste products from reactor fuel processing.

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 11403, 12240, 12241, 12256, 12719

12224 (LBL—10309) **Effect of CO_2 pressure on the rate of decomposition of calcite ($CaCO_3$).** Darroudi, T. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jan 1980. Contract W-7405-ENG-48. 22p. Dep. NTIS, PC A02/MF A01.

Thesis.

The Langmuir method was employed to measure the rate of CO_2 escape from (1011) cleavage surfaces of calcite ($CaCO_3$) single crystals at temperatures from 893°K to 1073°K and at background pressures of CO_2 from 10^{-5}P/sub eq/ to 4 x 10^{-2}P/sub eq/, where P/sub eq/ is the equilibrium decomposition pressure. Rates of decomposition measured in vacuum were in good agreement with earlier studies carried out under similar conditions. The rates were relatively sensitive to the CO_2 pressure at pressures of the order of 10^{-2}P/sub eq/, but were essentially independent of CO_2 pressure for a range of lower pressures that cause a flux of CO_2 gas against the $CaCO_3$ sample surface up to about 10^3 times the flux that leaves the $CaCO_3$ in vacuum. In this latter CO_2 pressure range, the rate limiting process is probably a solid state diffusional step or surface step of CO_2. The rate limiting process at CO_2 pressures near P/sub eq/ must be different, but more data are needed to determine what that process may be.

12225 (UCID—18339) **Electrical conductivity of caustic aluminate solutions at various concentrations and temperatures.** Landrum, J.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Jan 1980. Contract W-7405-ENG-48. 16p. Dep. NTIS, PC A02/MF A01.

The electrical conductivity was measured for caustic aluminate solutions containing 4, 6, and 8M NaOH. Concentrations of $Al(OH)_4^-$ ranged from 0.3 to 4M, and temperature varied from 45 to 75°C. Arrhenius plots formed a linear family of curves for each solution studied, and a linear relationship was established between the conductivity and the square root of the total solution concentration. A mathematical equation was developed that allows one to calculate the $Al(OH)_4^-$ concentration from a conductivity measurement, if the temperature and NaOH concentration are known.

12226 **Sterically hindered, saddle-shaped complexes of palladium(II) and platinum(II) and their reaction with iodine.** Jircitano, A.J. (Univ. of Kansas, Lawrence); Timken, M.D.; Mertes, K.B.; Ferraro, J.R. *J. Am. Chem. Soc.;* **101**: No. 26, 7661-7667(19 Dec 1979).

The synthesis and characterization of I_2 reaction products of palladium(II) and platinum(II) with the tetraaza macrocycle tetrabenzo[b,f,j,n][1,5,9,13]tetraazacyclohexadecine (TAAB) from $[M(TAAB)][BF_4]_2$ are described. X-ray structural results for $[Pd(TAAB)][BF_4]_2$ show the complex to crystallize in the monoclinic space group $P2_1/c$ with unit cell dimensions a = 16.927 (6) A, b = 11.757 (7) A, c = 15.559 (4) A, and β = 118.87 (2)°. The immediate coordination sphere of the palladium consists of the four nitrogens situated on a saddle-shaped surface with the palladium located essentially in the center. The ligand system is decidedly saddle shaped, with the benzo groups forming cavities 2.70 A deep above and below the PdN_4 surface. In the presence of I_2 these complexes react to form a complex with the stoichiometry $[M(TAAB)][I_3]_{2.7}$. The presence of I_3^- and absence of I_2 were confirmed by both far-infrared and Raman spectroscopy. Mid-infrared and ESR evidence substantiates that ligand oxidation has not occurred. Electrical conductivity measurements using dc two-probe techniques indicate an unusual pressure dependence, whereby up to a 1000-fold increase in conductivity at up to 10 kbar pressure is noted. Single-crystal conductivity measurements for $[Pt(TAAB)][I_3]_{2.7}$ indicate conductivities on the order of the partially-comoxidized bisdioximates ($10^{-4}\Omega^{-1}cm^{-1}$)while the palladium analogue

12227 **Synthesis and structure of (eta-C_5H_5)W(PPh_3)(CO)(CSPh): transformation of a thiocarbonyl ligand into a carbyne ligand.** Greaves, W.W.; Angelici, R.J.; Helland, B.J.; Klima, R.; Jacobson, R.A. (Iowa State Univ., Ames). Contract W-7405-ENG-82. *J. Am. Chem. Soc.;* **101**: No. 25, 7618-7620(5 Dec 1979).

The arylation reaction (eta-C_5H_5)W(PPh_3)(CO)(CS)I + LiPh → (eta-C_5H_5)W(PPh_3)(CO)(CSPh) + LiI (5) reduces the multiple bonding in the terminal CS ligand of (eta-C_5H_5)W(PPh_3)(CO)(CS)I to a C-S single bond in the carbyne product. The previously reported alkylation $(Ph_2PCH_2CH_2PPh_2)_2W(CO)(CS) + MeOSO_2F \rightarrow (Ph_2PCH_2CH_2PPh_2)_2W(CO)(CSMe)^+SO_3F^-$ (1), and Lewis adduct formation reactions of terminal CS groups in electron-rich complexes presumably also yield CSR carbyne complexes. These results suggest that similar adducts of terminal CO ligands could be reasonable intermediates in catalytic reactions of carbon monoxide which lead to the cleavage of the carbon-oxygen triple bond. A single crystal of (eta-C_5H_5)W(PPh_3)(CO)(CSPh) ~ 0.2 x 0.15 x 0.4 mm was chosen for the x-ray diffraction study. The average distance from the tungsten to the cyclopentadienyl carbon atoms is 2.366 A. Data were given for the other ligands. 1 figure. (DP)

12228 **Metal core binding energy and charge delocalization in $[Os(NH_3)_4ClN_2Cl(NH_3)_4Os]Cl_5$, a binuclear mixed-valence osmium complex: an ESCA study.** Lazarus, M.S. (City Univ. of New York, Bronx); Sham, T.K. *J. Am. Chem. Soc.;* **101**: No. 25, 7622-7623(5 Dec 1979).

The measurement of the Os 4f spectrum of $([Os(NH_3)_4Cl]_2N_2)Cl_5$ was repeated. Only one set of Os 4f spin-orbit coupled peaks was seen, with some relatively weak satellites (~ 13% of the main peak) on the high binding energy side of the spectrum. This, the first observation of only one set of lines in a well-characterized ligand bridged binuclear transition metal mixed-valence compared is clear confirmation of the fact that here one has a single delocalized initial state. For points of comparison, Os 4f spectra were obtained from $[Os(NH_3)Cl]Cl_2$, an Os(III) compound, and $[Os(NH_3)_5N_2]Cl_2$, and Os(II) compound. The presence of satellites in the Os(II) compounds, $[Os(NH_3)_5N_2]Cl_2$ and the mixed-valence compounds, may be associated with the N_2 ligand. N_2 is isoelectronic with CO; and in addition, the π back-bonding effect is very strong in Os(II) analogous to some metal carbonyls. The ground- and excited-state levels arising from N_2 and Os(II) interaction may induce, during photoe-

mission, monopole transitions which give rise to observable satellites. 1 figure, 1 table. (DP)

12229 Conformational preferences and electronic structures of $Ni(C_2H_4)_2$ and $Ni(C_2H_4)_3$. Pitzer, R.M. (Ohio State Univ., Columbus); Schaefer, H.F. III. Contract W-7405-ENG-48. *J. Am. Chem. Soc.;* **101**: No. 24, 7176-7183(21 Nov 1979).

Nonempirical molecular electronic structure theory has been applied to the organometallic systems bis(eta²-ethene)-nickel(0) and tris(eta²-ethene)nickel(0). Three types of contracted Gaussian basis sets have been used in conjunction with restricted self-consistent-field theory. The middle basis set may be labeled Ni(14s 9p 6d/10 s 6p 3d), C (10s 6p/6s 3p), H(5s/3s) and is perhaps the most complete basis set used to date for an experimentally known organotransition metal complex such as $Ni(C_2H_4)_3$. The chosen basis comes very close to reproducing the exact Hartree-Fock term splittings for the nickel atom. For $Ni(C_2H_4)_2$ the twisted (D/sub 2d/) and planar (D/sub 2h/) conformations are predicted to lie energetically within 0.1 kcal of each other. For the $Ni(C_2H_4)_3$ complex, however, the planar conformation lies ~ 24 kcal lower than the upright form. Both of these predictions are in qualitative accord with the earlier semiempirical work of Roesch and Hoffmann. The lowest D/sub 2h/ triplet state of $Ni(C_2H_4)_2$ is of ^3B/sub 3u/ symmetry, and a number of other electronic states were also investigated. The ionization potentials of both molecules were predicted and large deviations from Koopmans' theorem were found. Mulliken population analyses are also reported and used to qualitatively discuss the electronic structures. 4 figures, 9 tables.

12230 Rates of deprotonation and pK/sub a/ values of transition metal carbonyl hydrides. Walker, H.W.; Kresge, C.T.; Ford, P.C.; Pearson, R.G. (Univ. of California, Santa Barbara). Contract DE-AS03-76SF0034. *J. Am. Chem. Soc.;* **101**: No. 24, 7428-7429(21 Nov 1979).

Described here are kinetic and equilibrium deprotonation-protonation data for several tetranuclear group 8 metal hydride clusters of the general formulae $H_4M_4(CO)_{12}$ and $H_2M_4(CO)_{13}$ and of two mononuclear analogues $H_2M(CO)_4$. Included are quantitative rate data for the deprotonation of a metal carbonyl hydride cluster; a typical example is $H_4Ru_4(CO)_{12} + CH_3O^-$ k₁ reversible k/sub -1/ $H_3Ru_4(CO)_{12}^- + CH_3OH$ (1). Rates were determined in a Durrum-Gibson D110 stopped-flow spectrophotometer. The metal complex concentration was in the range of 1×10^{-5} to 1×10^{-4} M and the concentration of sodium methoxide varied from 1×10^{-4} to 5×10^{-2} M. Reactions were found to be first order for several half-lives, and plots of K/sub obsd/ vs the base concentration were linear with a nonzero intercept. The slope gives k_1; the intercept gives k/sub -1/. The values of k_1 are remarkably small for a base as strong as methoxide ion. Rates of proton removal from the ruthenium and osmium hydrides are quite comparable with rates of reaction of nitroparaffins with hydroxide ion; there were slow protonation rates for $H_3Ru_4(CO)_{12}^-$ and $H_3Os_4(CO)_{12}^-$ relative to the other tetranuclear anions. X-ray diffraction studies show that the carbonyl and ruthenium frameworks (in the solid phase) are qualitatively the same for $[PH_3P)_2N]$-$[H_3Ru_4(CO)_{12}]$ as for $H_4Ru_4(CO)_{12}$. 1 table. (DP)

12231 Crystal and molecular structure of a cryptate complex of samarium: $C_{18}H_{36}O_6N_2Sm_2(NO_3)_6.H_2O$. Burns, J.H. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Inorg. Chem.;* **18**: No. 11, 3044-3047(Nov 1979).

A compound made by reacting $Sm(NO_3)_3$ with the cryptand designated [2.2.2] was analyzed by single-crystal x-ray diffraction to determine its composition, $C_{18}H_{36}O_6N_2Sm_2(NO_3)_6.H_2O$, and its molecular structure. The triclinic unit cell has a = 14.815 (3) A, b = 8.813 (1) A, c = 13.253 (3) A, $\alpha = 91.51\ (2)^0$, $\beta = 92.48\ (2)^0$, and $\gamma = 86.73\ (2)^0$; the space group is P1 and Z = 2. The structure was determined by the heavy-atom method and refined by least squares. Positions and anisotropic thermal parameters of the 53 independent nonhydrogen atoms of the asymmetric unit were adjusted until the agreement factor, R/sub F/, reached 0.038 for 6941 observations. The crystal contains two complex ions: $(Sm[2.2.2]NO_3)^{2+}$ and $[Sm(NO_3)_6.H_2O]^{2-}$. In the complex cation the Sm^{3+} ion is enclosed in the bicyclic ligand and is bonded to its six O atoms and two N atoms as well as to a bidentate NO_3^- ion inserted between strands of the ligand. Considerable distortion of the ligand from its conformation in the uncomplexed state is observed. The complex anion has five bidentate NO_3^- ions and a water molecule surrounding a Sm^{3+} ion. There are no especially close contacts between ions other than for some weak hydrogen bonds. 2 figures, 3 tables.

12232 Effects of Li_2SO_4 addition, moisture, and LiOH on the ionic conductivity of Li_5AlO_4. Biefeld, R.M.; Johnson, R.T. Jr. (Sandia Labs., Albuquerque, NM). Contract AT(29-1)-789. *J. Solid State Chem.;* **29**: No. 3, 393-399(Sep 1979).

The ionic conductivity and thermal properties of $80Li_5AlO_4 + 20Li_2SO_4$, $75Li_2SO_4 + 25LiOH$, and $50Li_2SO_4 + 50LiOH$ composite polycrystalline samples have been determined in both wet and dry environments. A large increase in the ionic conductivity of $80Li_5AlO_4 + 20Li_2SO_4$ in a wet environment above ~ 350°C is due to the presence of LiOH. This same increase in conductivity is found for the two LiOH and Li_2SO_4 mixtures and is related to a eutectic region in the Li_2SO_4-LiOH system. The phase diagram for the Li_2SO_4-LiOH system was determined and supports this conclusion. The conductivity of $80Li_5AlO_4 + 20Li_2SO_4$ in a dry environment is thermally activated $[\sigma = \sigma_0 \exp(-E/kT)]$ with E = 0.66 eV and $\sigma_0 = 450\ (\Omega\text{-cm})^{-1}$. The addition of Li_2SO_4 to Li_5AlO_4 increases the total conductivity but decreases the electronic conductivity. Pressed pellets of Li_5AlO_4 and $80Li_5AlO_4 + 20Li_2SO_4$ are stable in lithium up to at least 550 and 450°C, respectively.

12233 Oxygen potential of near- and non-stoichiometric urania-25 mol% plutonia solid solutions: a comparison of thermogravimetric and galvanic cell measurements. Woodley, R.E. (Hanford Engineering Development Lab., Richland, WA (USA)); Adamson, M.G. (General Electric Co., Pleasanton, CA (USA). Vallecitos Nuclear Center). *J. Nucl. Mater.;* **82**: No. 1, 65-75(Jun 1979).

To resolve discrepancies between the existing low temperature ΔG/sub O_2/ (mean) data for solid solution mixed (U, Pu)-oxide nuclear fuel material, additional measurements have been performed on $U_{0.75}Pu_{0.25}$ employing a combined thermogravimetric (TGA) and solid-electrolyte galvanic cell technique. These measurements, which were performed at temperatures between 800 and 1000°C, and for O:M ratios in the range 1.940 to 2.028, are reasonably self-consistent and show good agreement with the results of previous TGA measurements. However, they do not corroborate the earlier EMF cell measurements of Markin and McIver (1967). Possible explanations for errors in these earlier EMF cell results are examined. The new results indicate that the ΔG/sub O_2/ (mean) of stoichiometric mixed oxide at typical outer surface fuel temperature is close to -100 kcal/mol O_2 (-419 kJ/mol O_2). Attempts have been made to fit the new ΔG/sub O_2/ (mean) data to two equations derived from recent defect models, and it is shown that neither equation accurately represents the experimental p/sub O_2/ - x data over more than a short range of x.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 12250

12234 (UCRL—15133) High-Voltage Power Supply System for Laser Isotope Separation. Ketaily, E.C.; Buckner, R.P.; Uhrik, R.L. (Energy Technology Engineering Center, Canoga Park, CA (USA); Rockwell International Corp., Dallas, TX (USA). Collins Telecommunications Systems Div.). 26 Jun 1979. Contract W-7405-ENG-48. 55p. (SANL—707-101). Dep. NTIS, PC A04/MF A01.

This report presents several concepts for Laser High-Voltage Power Supply (HVPS) Systems for a Laser Isotope Separation facility. Selection of equipments and their arrangement into operational systems is based on proven designs and on application concepts now being developed. This report has identified a number of alternative system arrangements and has provided preliminary cost estimates for each. The report includes a recommendation for follow-on studies that will further define the optimum Laser HVPS Systems. Brief descriptions are given of Modulator/Regulator circuit trade-offs, system control interfaces, and their impact on costs.

ORGANIC CHEMISTRY

12235 (COO—4227-8) Coal anion structure and chemistry of coal alkylation. Eighth quarterly progress report, December 1, 1978-February 28, 1979. Stock, L.M. (Chicago Univ., IL (USA)). 1979. Contract EF-77-S-02-4227. 24p. Dep. NTIS, PC A02/MF A01.

Three areas of research are discussed in this report. First, work on the reactions for the formation of soluble alkylated products is discussed. Second, the spectroscopic properties of the alkylated products are discussed. Third, the nature of the reaction between tetralin-d_{12} and coal at 400° is examined.

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 12226, 12227, 12228, 12229

12236 (BNL—26887) Determination of structural water by neutron protein crystallography: an analysis of the carbon monoxide myoglobin water structure. Schoenborn, B.P.; Hanson, J.C. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 10p. (CONF-790917—18). Dep. NTIS, PC A02/MF A01.

From American Chemical Society national meeting; Washington, DC, USA (10 Sep 1979).

An ideal technique for studying the water structure of proteins using neutron crystallography is discussed. The advantages of using deuterons (D_2O) instead of hydrogen (H_2O) are explained. The results of an early unrefined met myoglobin neutron analysis are presented. More recent high resolution x-ray analysis of met myoglo-

bin and refined neutron analysis of carbon monoxide myoglobin water structure were compared. Neutron maps were included.

12237 (LA—7756-MS) Atom positions of pentaerythritol tetranitrate (PETN, $C_5H_8N_4O_{12}$) determined by x-ray and by neutron diffraction. Conant, J.W.; Cady, H.H.; Ryan, R.R.; Yarnell, J.L.; Newsam, J.M. (Los Alamos Scientific Lab., NM (USA)). Dec 1979. Contract W-7405-ENG-36. 17p. Dep. NTIS, PC A02/MF A01.

Booth and Llewellyn determined the crystal structure of PETN in 1947. Their structure, refined by Trotter in 1963, agrees essentially with ours, which was constructed with new intensity data taken using a Picker FACS-I computer-controlled diffractometer. Our refinement located the hydrogen atoms with reasonably accuracy because our diffractometer is more sensitive than the film data of the earlier workers. A powder neutron diffraction pattern of deuterated PETN was taken on the diffractometer at the Omega West Reactor at the Los Alamos Scientific Laboratory. These intensity data were refined using the Rietveld Profile Analysis program as modified by R. Von Dreele of Arizona State University. We discuss possible explanations of systematic differences between the interatomic distances and angles determined by x-ray diffraction and those determined by neutron diffraction.

12238 (PB—294046) Reactions of oxy radicals in the atmosphere. Final report jun 75-78. Hendry, D.G.; Kenely, R.A.; Davenport, J.E.; Lan, B.Y. (SRI International, Menlo Park, CA (USA)). Mar 1979. 81p. NTIS, PC A05/MF A01.

Results are presented of a research program concerned with the study of selected reactions of importance in atmospheric chemistry. The decomposition of peroxyacetyl nitrate (PAN) was studied over the temperature range 25-39C. The rate constant was determined to be log k = 16.29 - 26,910/4.576 T. The reactions of acetylperoxy radicals with NO and NO2 were investigated. The ratio of the rate constants for these reactions was determined to be k(NO)/k(NO)2 = 3.0 + or - 0.7. The products of the reaction of OH with various aromatic compounds were also determined. The investigation showed that the reaction of OH with simple aromatic hydrocarbons proceeds by two major pathways, abstraction of a hydrogen atom in the benzylic position or addition of OH to the aromatic ring. Ratios of the rate of abstraction versus addition were determined for toluene, 1,4-dimethylbenzene and 1,3,5-trimethylbenzene. Results of a study to elucidate the products and mechanism of the reaction of OH with benzaldehyde are also presented. Research showed that this reaction proceeds exclusively by abstraction of the aldehydic hydrogen.

12239 Radicals of isobacteriochlorins: models of siroheme and sirohydrochlorin. Richardson, P.F.; Chang, C.K.; Spaulding, L.D.; Fajer, J. (Brookhaven National Lab., Upton, NY). Contract EY-76-C-02-0016. *J. Am. Chem. Soc.;* **101**: No. 26, 7736-7738(19 Dec 1979).

To probe the magnetic, optical, and redox characteristics of the isobacteriochlorin class, described here are molecular orbital calculations and ESR, ENDOR, optical, and electrochemical results for two model compounds: zinc tetraphenyl isobacteriochlorin, whose recently determined x-ray structure verifies that two adjacent pyrrole rings are reduced in isobacteriochlorins, and dimethyloctaethyl isobacteriochlorin, a compound which is a close analogue, structurally and spectrally to sirohydrochlorin. 5 figures, 1 table.

12240 Charge transfer and partial oxidation in the conductive hydrocarbon-iodine complex 2-perylene.$3I_2$. Teitelbaum, R.C. (Northwestern Univ., Evanston, IL); Ruby, S.L.; Marks, T.J. *J. Am. Chem. Soc.;* **101**: No. 25, 7568-7573(5 Dec 1979).

It has long been thought that the highly conductive complexes formed between elemental iodine and various polycyclic aromatic hydrocarbons are molecular complexes, i.e., they contain iodine as I_2. In this contribution we report resonance Raman and iodine-129 Moessbauer spectroscopic characterization of the form of the iodine in the most highly conductive of these materials: 2perylene.$3I_2$. We find that 2perylene.$3I_2$ is not a molecular complex, but rather a partially oxidized, mixed-valence compound, the charge distribution of which can be approximately formulated on the basis of the spectral data as $(perylene)^{+0.4}(I_5^- \cdot 2I_2)_{0.4}$. 3 figures, 2 tables.

12241 1,1-dilithioethylene. A ground-state triplet olefin with nearly free rotation about the double bond. Laidig, W.D.; Schaefer, H.F. III. (Univ. of California, Berkeley). Contract W-7405-ENG-48. *J. Am. Chem. Soc.;* **101**: No. 24, 7184-7188(21 Nov 1979).

Molecular electronic structure theory has been applied to the $CLi_2{=}{=}CH_2$ molecule 1,1-dilithioethylene. Both planar and triplet structures were considered for each of the lowest singlet and triplet electronic states. Geometry optimizations were carried out at the self-consistent-field (SCF) level of theory using a basis set of better than double zeta quality: C(9s 5p 1d/4s 2p 1d), Li(9s 4p/4s 2p), H(4s/2s). The predicted C=C bond distances are 1.356 (planar singlet), 1.334 (twisted singlet), 1.322 (planar triplet), and 1.323 A (twisted triplet). The analogous Li-C-Li bond angles are 133.6, 104.1, 73.9, and 75.5°, while the corresponding C-Li bond distances are 2.000, 1.866, 2.106, and 2.064 A. SCF theory predicts the twisted triplet to be the ground state, followed energetically by the planar triplet (1.2 kcal), twisted singlet (28.4 kcal), and planar singlet (29.3 kcal). The effects of electron correlation were investigated by configuration interaction (CI) including single and double excitations. The ordering of states is unchanged, with the relative energies being 0.0, 1.4, 14.0, and 15.5 kcal. After Davidson's correction for the effects of unlinked clusters, the same relative energies become 0.0, 1.4, 10.5, and 12.5 kcal. Qualitative features of the CLi_2CH_2 electronic structures are discussed in terms of orbital energies, Mulliken populations, and predicted dipole moments. 3 figures, 4 tables.

12242 Mechanism of the keto-enol tautomerism in radical cations and gas-phase closed-shell systems. Splitter, J.S.; Calvin, M. (Univ. of California, Berkeley). *J. Am. Chem. Soc.;* **101**: No. 24, 7329-7332(21 Nov 1979).

The enol-keto tautomerism in radical cations has been considered to involve a symmetry-forbidden 1,3-hydrogen shift. An alternative process involves two consecutive 1,2-hydrogen shifts. The ΔH/sub f/'s of the intermediate ions formed by a 1,2-hydrogen shift in the radical cations of phenol and the enol form of acetic acid have been calculated to be 220 and 191 kcal/mol, respectively. These ΔH/sub f/'s indicate barriers to the keto-enol tautomerism via two consecutive 1,2-hydrogen shifts of 50 and 47 kcal/mol, respectively, in good agreement with previously determined experimental values of 55 and 51 +- 10 kcal/mol, respectively. The tautomerism in the closed-shell systems 1-butene reversible 2-butene, vinyl alcohol reversible acetaldehyde, $H_2C{=}{=}O^+CH_3$ reversible $H_3CO^+{=}{=}CH_2$, and $CH_3CH{=}{=}O^+CH_3$ reversible $CH_3CH_2O^+{=}{=}CH_2$ is discussed in terms of two consecutive 1,2-hydrogen shifts.

12243 Production of singlet molecular oxygen from the O_2 quenching of the lowest excited singlet state of rubrene. Wu, K.C.; Trozzolo, A.M. (Univ. of Notre Dame, IN). *J. Phys. Chem.;* **83**: No. 22, 2823-2826(1 Nov 1979).

The efficiencies of the rubrene-sensitized photooxidation of 1,3-diphenylisobenzofuran in benzene, acetone, cyclohexane, n-hexane, and isooctane have been measured. The measured efficiencies are analyzed with data from the oxygen quenching of the rubrene fluorescence in the same solvents. It is shown that about 1.5 molecules of singlet oxygen are produced as a result of the primary process in which a rubrene molecule in the S_1 state is quenched by ground state oxygen. This indicates that there is a substantial efficiency for the direct production of singlet oxygen by the oxygen quenching of rubrene S_1 excited states: $S_1 + {}^3O_2 \rightarrow T_1 + {}^1O_2$. 1 figure, 1 table.

12244 Electronic rearrangements during chemical reactions. II. Planar dissociation of ethylene. Cheung, L.M.; Sundberg, K.R.; Ruedenberg, K. (Ames Lab., IA). *Int. J. Quant. Chem.;* **16**: No. 5, 1103-1139(Nov 1979).

The direct dissociation of ethylene into two methylenes is studied along the least motion reaction path by means of an ab initio multiconfiguration self-consistent-field (MCSCF) calculation. All eight configurations arising from those valence orbitals that form the CC bonds, seven of them singlet coupled and one triplet coupled, are taken into account. The HCH bond angle is optimized along the entire reaction path. Separate MCSCF optimizations are carried through for the lowest two states of ^{1}A/sub g/ symmetry. The (^{1}A/sub g/$\sigma^2\pi^2$) ethylene ground state dissociates into two ($^3B_1\sigma\pi$) ground-state methylenes. The (^{1}A/sub g/$\sigma^2\pi^{*2}$) excited state of ethylene dissociates into two ($^1A_1\sigma^2$) excited methylenes. It is established that both these dissociations proceed without any barrier in the energy curve. In the ground state, where orbital symmetry is conserved, the π-bond breaks before the σ-bond, and the calculated heat of reaction agrees within 6 kcal/mol with the experimental value. In the excited state, where orbital symmetry is not conserved, the nonbonded repulsion between methylene σ^2 lone pairs is found to blend into the antibonding character of the excited ethylene, yielding an energy curve that is everywhere repulsive. However, the variation of the HCH angle during the dissociation process is not simple, initially it expands and subsequently it contracts. Quantitative analytical approaches are developed which furnish conceptual interpretations of the orbital changes and configurational changes along the reaction path.

ISOTOPE EFFECTS

REFER ALSO TO CITATION(S) 12269

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

12245 Hydrogen-deuterium exchange: perdeuteriohydridotris(hexamethyldisilylamido)-thorium(IV) and -uranium(IV). Simpson, S.J.; Turner, H.W.; Andersen, R.A. (Univ. of California, Berkeley). *J. Am. Chem. Soc.;* **101**: No. 26, 7728-7729(19 Dec 1979).

This communication describes an unusual H-D exchange process in $HU[N(SiMe_3)_2]_3$ and $HTh[N(SiMe_3)_2]_3$, examples of f^2 and f^0 electronic configurations, respectively. Elemental analysis, ab-

sence of a ^1H NMR spectrum, and isolation of $[(CD_3)_3Si]_2ND$ after hydrolysis confirm that all 55 hydrogen atoms have been exchanged for deuterium. The mechanism is discussed. 1 figure.

ELECTROCHEMISTRY

12246 (ISM—251) **Lattice gas model for the metal-electrolyte interface.** Liu, S.H. (Ames Lab., IA (USA)). 1979. Contract W-7405-ENG-82. 17p. (CONF-790956—3). Dep. NTIS, PC A02/MF A01.

From Conference on non-traditional approaches to the study of the solid-electrolyte interface; Snowmass, CO, USA (23 Sep 1979).

A lattice model is proposed for the physical properties of the metal-electrolyte interface. It is shown that near the electrode where the potential and the electric field are very high, the continuum model of Gouy and others breaks down, but the lattice model gives a physically reasonable description of the properties of the electrolyte in the interface region.

12247 **Photoelectrochemical conversion of optical energy to electricity and fuels.** Wrighton, M.S. (Massachusetts Inst. of Tech., Cambridge). *Acc. Chem. Res.;* **12**: No. 9, 303-310(Sep 1979).

Significant solar energy conversion can be achieved with a photoelectrochemical device. Photogeneration of storable chemical fuels in the form of electrolytic products is possible, in addition to converting light only to electricity when the redox reaction occurring at one electrode is the reverse of that at the other. This paper outlines recent research accomplishments in the field of photoelectrochemistry. 50 references, 3 figures, 3 tables.

PHOTOCHEMISTRY

REFER ALSO TO CITATION(S) 12243, 12247, 12552

12248 (DOE/ER/10392—1) **Excited state electron transfer in systems with a well-defined geometry. Progress report, May 1, 1979-April 30, 1980.** Kaufmann, K.J. (Illinois Univ., Urbana (USA). School of Chemical Sciences). Dec 1979. Contract AC02-79ER10392. 25p. Dep. NTIS, PC A02/MF A01.

To determine what are the important criteria governing efficient light-induced electron transfer, we have been studying cyclophanes formed by joining two chlorophyll macrocycles together with two covalent linkages. The properties of the cofacial dimer can be altered by adding one or two magnesium atoms. When a cyclophane containing only one metal atom is excited electron transfer takes place in under ten picoseconds. Evidence for the formation of a state having a great deal of charge transfer interaction or perhaps even a radical pair is found in the time resolved difference spectrum which shows a contribution due to a cation of the magnesium containing macrocycle and an anion of the metal free portion of the molecule. The lifetime of the charge transfer state is 2.4 nsec. This would indicate that we have stabilized the charge separation for a relatively long time. The metal free dimer has an excited state product which does not appear to be a triplet state. The lifetime of this product is very long. The identity of the product has not as yet been obtained. It too could be a charge transfer state. If this is true, we have succeeded in stabilizing the charge separation for an extremely long time. Finally, we observed that the photophysical properties of the chlorophyll macrocycle are modified by reduction of the vinyl group on ring I.

12249 (LBL—9981) **Absolute photodissociation quantum yields of NO_3 and N_2O_5 by tunable laser flash photolysis-resonance fluorescence.** Magnotta, F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 225p. Dep. NTIS, PC A10/MF A01.

Thesis.

Low levels of NO_3 were maintained in an ozone-free system by carefully controlled unimolecular thermal decomposition of N_2O_5 in N_2 at a total pressure of 10 torr. N_2O_5 (and HNO_3) concentrations were measured by infrared absorption spectroscopy, while NO_2 levels were determined by laser induced fluorescence. Representative of the two possible photolytic channels are NO and O, which were measured by detecting resonantly scattered vacuum ultraviolet radiation from microwave powered discharge lamps. Results of NO_3 photolysis experiments from 4700 to 6850 A indicate that oxygen atom is the major product and is produced in the wavelength range between 4700 and 6350 A. The maximum quantum yields for O and NO are: phi$_0$ (max) = 1.00 at λ 5850 A, and phi/sub NO/(max) = 0.32 at λ = 5920 A. NO_3 absorption cross sections at two wavelengths were higher than those of Graham. Quantum yield values and the solar flux in the lower atmosphere resulted in the following photodissociation coefficients at a solar zenith angle of 0°: j(O + NO_2) = 0.18 +- 0.018 s^{-1}, and j(NO + O_3) = 0.022 +- 0.002 s^{-1}. The primary photoproducts from ultraviolet photolysis of N_2O_5 include an oxygen atom, with NO not being produced to any appreciable extent, with an upper limit of: phi/sub NO/(N_2O_5) $\leq$ 0.11. phi$_0$ values were found to vary with N_2O_5 concentration, in excellent agreement with angle of Connell. The rate constant for the reaction of O + NO_2 was found to be: k/sub O, NO_2 = 1.03 +- 0.008 x 10^{-11} cm^3.$molecule^{-1}$.s^{-1}.

12250 **Isotope enrichment and stereochemistry of the products from the reaction of electronically excited iodine monochloride with cis- and trans-1,2-dibromoethylene.** Datta, S.; Brauman, J.I.; Zare, R.N. (Stanford Univ., CA). *J. Am. Chem. Soc.;* **101**: No. 24, 7173-7176(21 Nov 1979).

The reaction of electronically excited iodine monochloride with cis- and trans-1,2-dibromoethylene has been studied in detail. Selective excitation of ^{37}Cl, using a CW dye laser, gave cis- and trans-1-bromo-2-chloroethylene products containing up to 78.4 and 73.9% ^{37}Cl, respectively. The quantum yield of the two products together was about 30%. The product stereochemistry for the reaction of ICl* with 1,2-dibromoethylene is similar to that of free Cl atoms, but differs from that of the competing dark reaction with ICl. A mechanism for reaction with ICl* giving preferential retention of geometry is proposed. 1 figure, 5 tables.

12251 **Sensitized photooxygenations of Δ^2-oxazolin-5-ones and related studies.** Dixit, V.M. (Indian Inst. of Tech., Kanpur); Bhat, V.; Trozzolo, A.M.; George, M.V. *J. Org. Chem.;* **44**: No. 23, 4169-4173(9 Nov 1979).

Sensitized photooxygenations of a few Δ^2-oxazolin-5-ones such as 2,4-diphenyl-Δ^2-oxazolin-5-one (3a), 4-benzyl-2-phenyl-Δ^2-oxazolin-5-one (3b), and 4-benzylidene-2-phenyl-Δ^2-oxazolin-5-one (17) have been studied, using Rose Bengal as a sensitizer. The photoxygenation of 3a in a mixture of benzene and methanol for 0.25 h gave a mixture of bi-4,4'-(2,4-diphenyl-Δ^2-oxazolin-5-one) (9a, 44%) and benzamide (28%), whereas the photooxygenation of 3a in methanol for 0.5 h gave a mixture of dibenzamide (8a, 40%) and benzamide (49%). In contrast, the irradiation of 3a in either benzene or cyclohexane gave only benzamide. Nickel peroxide oxidation of 3a gave a 38% yield of the bioxazolinone 9a. Direct irradiation of 9a in either benzene or acetone gave benzamide, whereas the thermolysis of 9a in refluxing o-dichlorobenzene gave a 3% yield of 2,3,5,6-tetraphenylpyrazine (16). Photooxygenation of 3b gave a 42% yield of N-benzoylphenylacetamide (8b), whereas the direct irradiation of 3b gave only benzamide. Nickel peroxide oxidation of 3b gave bi-4,4'-(4-benzyl-2-phenyl-Δ^2-oxazolin-5-one) (9b, 40%). Direct irradiation of 9b gave exclusively benzamide. The photooxygenation of 17 in methanol gave a mixture of the α-benzamidocinnamate 18 (53%) and benzamide (29%), whereas the direct irradiation of 17 gave a mixture of α-benzamidocinnamic acid (20) (31%) and benzamide (52%). Reasonable mechanisms have been suggested for the formation of the different products in these reactions.

12252 **Photoinduced redox reactions of macrocyclic complexes with d^7 (nickel(III)) metal ions. Photoredox processes of equatorial and axial ligands.** Ferraudi, G. (Univ. of Notre Dame, IN). *Inorg. Chem.;* **18**: No. 11, 3230-323 3(Nov 1979).

Ultraviolet irradiations of Ni([14]dieneN$_4$)$(CH_3CN)_2^{3+}$ or Ni(tet a)$(CH_3CN)_2^{3+}$ induce a reduction of the metal center and oxidation of the coordinated acetonitrile. The photoprocesses of the tet a and [14]dieneN$_4$ complexes have the same threshold energy for photoreactivity, E/sub th/ $\approx$ 79.4 kcal/mol. However, the limiting yield for Ni(tet a)$(CH_3CN)_2^{3+}$, phi = 0.03, is smaller than the yield for Ni([14]dieneN$_4$)$(CH_3CN)_2^{3+}$, phi = 0.15. The photooxidation of the imino groups of the macrocycle has been observed in flash photolyses of Ni([14]dieneN$_4$)$(CH_3CN)_2^{3+}$ in the presence of sulfate ions. A Ni(II)-ligand radical (λ/sub max/ $\sim$ 535 nm, t/sub 1/2/ $\leq$ 600 μs) was detected in these irradiations. The photochemistries of the Ni(III) complexes have been associated with the population of charge-transfer ligand to metal states, CT/sub π-C==N $\rightarrow$ d-Ni/ and/or CT/sub π-imino $\rightarrow$ d-Ni/. 4 figures, 1 table.

RADIATION CHEMISTRY

REFER ALSO TO CITATION(S) 11249, 11343, 11344, 12113, 12649

12253 (CS-INIS—214) **Applied radiation chemistry and dosimetry.** Teply, J. (ed.). (Ceska Vedeckotechnicka Spolecnost, Prague (Czechoslovakia). Dum Techniky). Dec 1976. vp. (In Czech). (CONF-761276—). Ceska Vedeckotechnicka spolecnost, Dum techniky, Prague, Czechoslovakia.

From Seminar on applied radiation chemistry and dosimetry; Jevany, Czechoslovakia (6 Dec 1976).

Separate abstracts were prepared for individual items within the scope of the energy data base.

12254 (INIS-mf—5191) **Symposium on radiation chemistry. Summaries of reports.** (AN Gruzinskoj SSR, Tbilisi. Inst. Neorganiches-

koj Khimii i Ehlektrokhimii). 1978. vp. (In Russian). (CONF-7811147—(Summ.)). Dep. NTIS (US Sales Only).

From Symposium on radiation chemistry; Tbilisi, USSR (13 Nov 1978).

Separate abstracts were prepared for individual items within the scope of the energy data base. (DLC)

12255 (NDRL—2080) **Radiation Laboratory quarterly report, October 1, 1979-December 31, 1979.** (Notre Dame Univ., IN (USA). Radiation Lab.). 15 Jan 1980. Contract EY-76-C-02-0038. 41p. Dep. NTIS, PC A03/MF A01.

Investigations include: role of electron-phonon interaction in absorption spectra of trapped electrons; solvated electrons; energy loss process of slow electrons in matter; physical and chemical processes in irradiated liquefied rare gases; electron thermalization in neon, argon, krypton, xenon, and diatomic molecules; the effect of time-dependent activation energy on electron hopping transport; CO desorption and adsorption on Pt(111); studies of electron attachment to O_2 at low temperatures; theoretical identification of a radical produced by radiolysis of uracil; evidence for dynamic coupling in the molecular vibrations of crystalline meta-dinitrobenzene; the vibrational factor group splitting in crystalline aniline; absolute calibration of the thiocyanate pulse radiolysis dosimeter; rates and mechanisms of oxidation of substituted alkyl radicals by Ir(IV), Fe(III), and Mn(VII) in aqueous solutions; oxidation of hexachloroiridate(III) by Cl_2^- and Br_2^-; radiolysis of vinylsulfonic acid; intramolecular electron transfer in nitrobenzyl halides; radiation chemistry studies with heavy ions; and charge transfer photochemistry of Cu(II) complexes with Schiff bases. Abstracts of papers and reports published during the quarter are included.

12256 **Catalysis of the reduction of Tl^+ and of CH_2Cl_2 by colloidal silver in aqueous solution.** Henglein, A. (Univ. of Notre Dame, IN). *J. Phys. Chem.;* **83**: No. 22, 2858-2862(1 Nov 1979).

$(CH_3)_2COH$ radicals (1-hydroxy-1-methylethyl) do not reduce Tl^+ or CH_2Cl_2 in homogeneous aqueous solution. In the presence of 2.5×10^{-4} g atom/L of colloidal silver, Tl^+ is reduced to yield colloidal thallium, and CH_2Cl_2 to yield Cl^- plus CH_3Cl. These reactions occur in competition with the silver-catalyzed reduction of water. Tl^+ is reduced in a one-electron transfer reaction and CH_2Cl_2 in a two-electron transfer process. The effects are understood in terms of the colloidal particles acting as a pool for electrons that is continuously charged by the organic radicals and discharged by water or dissolved substrates. The specific rate for the CH_2Cl_2 reduction at the silver pool is 4.3×10^3 times greater than that of the water reduction. Electrochemical considerations are carried out to estimate a stationary potential of -0.62 V (vs the standard hydrogen electrode) for the electron pool and to discuss the energetics of the observed reactions and the possible role of adsorbed hydrogen atoms. Colloidal silver and organic radicals were radiolytically produced. 7 figures.

12257 **High-resolution absorption and fluorescence of the 1-hydrobinaphthyl radical in the irradiated naphthalene crystal.** Nakayama, T.; Sheng, S.J. (Univ. of Notre Dame, IN). *J. Phys. Chem.;* **83**: No. 22, 2869-2872(1 Nov 1979).

The strong absorption band at 710 nm in an irradiated naphthalene crystal was studied at 4.2 K. Evidence from the deuterium shift, the absorption spectrum in a 50:50 $C_{10}H_8$-$C_{10}D_8$ crystal, and the fluorescence spectrum indicates that the radical responsible for 710-nm absorption is the 1-hydrobinaphthyl radical. This radical is formed through the bimolecular reaction between a naphthyl radical and a naphthalene molecule and is stable at room temperature in the crystalline lattice. 3 figures, 2 tables.

12258 **Electron spin resonance study of γ-irradiated frozen aqueous solutions containing dipeptides. Mechanisms of radical reaction.** Sevilla, M.D.; D'Arcy, J.B.; Morehouse, K.M. (Oakland Univ., Rochester, MI). *J. Phys. Chem.;* **83**: No. 22, 2887-2892(1 Nov 1979).

The γ irradiation at 77 K of frozen aqueous solutions of over 14 peptides was investigated by ESR (electron spin resonance) spectroscopy. The investigation was composed of three parts. The first part consists of a study of simple dipeptides of glycine and alanine, i.e., Gly-Ala, Ala-Gly, and Ala-Ala. Detailed analyses were made of the radicals produced by the irradiation, their relative concentrations, and their stability as a function of temperature. The results show evidence for anion formation, primary deamination, and decarboxylation initially. This is followed by abstraction from the parent compound to form the α-carbon radical at the C-terminal residue. In the case of Ala-Ala there is evidence for hole stabilization at low temperature. In the case of Gly-Ala some secondary deamination is noted. In the second part the analysis of the final spectra for 11 dipeptides are reported. The final radicals were all found to be a result of abstraction from the α carbon of the C-terminal residue to produce the radical $NH_3^+CHRCONHCR'CO_2^-$. Radicals with R' = H or CH_2R'' produced a hyperfine coupling due to one proton of 18 to 19 G. Since 15 of the 20 common amino acid residues have a structure with R' = H or CH_2R'', the dominant final radical in proteins should produce a doublet spectrum. In the final portion, three dipeptides with aromatic side groups were studied in frozen H_2O solutions. It was found that electron attachment to the aromatic ring effectively competed with deamination of the primary amine group. The electron attachment to the aromatic ring was followed by protonation at a carbon site on the ring. The results for Gly-His were typical. Here we found a spectrum indicative of 25% protonation, 30% deamination, and 45% decarboxylation. For Gly-Tyr, phenoxyl radical formation was found to dominate decarboxylation as a decomposition pathway for the hole. 10 figures, 2 tables.

12259 **Electron spin resonance study of γ-irradiated frozen aqueous solutions containing N-acetylamino acids.** Sevilla, M.D.; D'Arcy, J.B.; Morehouse, K.M. (Oakland Univ., Rochester, MI). *J. Phys. Chem.;* **83**: No. 22, 2893-2897(1 Nov 1979).

The results of γ irradiation of a number of N-acetylamino acids at 77 K in frozen D_2O and H_2O solutions are reported. The radicals produced by the irradiation, their relative amounts, and their stability were studied as a function of temperature. The results found for ices of N-acetylalanine illustrate the reaction mechanisms found. At low temperatures (120 K) the peptide anion and decarboxylated species dominate the spectrum. Upon warming to 190 K the anion converts to the amide and fatty acid radical by secondary deamination: $CH_3CO^-NDCH(CH_3)CO_2^- + D^+ \rightarrow CH_3COND_2 + .CH(CH_3)CO_2^-$. Further warming to 220 K results in abstraction of the intermediate radicals from the parent compound to form the α-carbon radical: $CH_3CHCO_2^- + CH_3CONDCH(CH_3)CO_2^- \rightarrow CH_3CH_2CO_2^- + CH_3CONDCCH_3CO_2^-$. Results found for N-acetylglutamic acid show similar reactions and also show evidence for electron attachment to the two carboxyl groups as well as the peptide linkage. An investigation as a function of pD shows that the site of electron attachment is strongly pD dependent with the carboxyl groups being favored at low pD and the peptide linkage favored at high pD. 9 figures, 1 table.

12260 **Radiation-curable prepolymer.** Kudo, K.; Nakamura, K.; Tazawa, T. (to Dainippon Ink and Chemicals, Inc.). US Patent 4,164,486. 14 Aug 1979. Filed date 3 Jan 1978. 12p.

The object of this invention is to provide an isocyanate-curable prepolymer which will adhere to a metal substrate, has good curability and good physical and chemical properties. The product is prepared by the reaction of an organic diisocyanate with a hydroxyl-containing unsaturated monomer and a polyester polyol, preferably containing 2 to 4 hydroxyl groups per molecule. (The polyol should have an average mol wt of 800 to 6000 and a hydroxyl equiv wt of 200 to 3000, and should contain a dimer acid residue derived from 9 to 70%, based on the total wt of the starting materials.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

12261 (ORO—5172-14) **Nuclear chemistry progress report.** Viola, V.E. Jr. (Maryland Univ., College Park (USA)). Aug 1979. Contract EY-76-S-05-5172. 70p. Dep. NTIS, PC A04/MF A01.

Research activities during the period August 1, 1978 to July 31, 1979 are summarized. The major effort has continued to be devoted to the study of nucleon exchange and energy dissipation mechanisms in damped heavy-ion reactions. Among the most significant accomplishments of the program during the past year has been the measurement of damped fragment spectra with discrete Z and A resolution. These studies provided detailed information on the A/Z equilibration and nucleon exchange processes in damped heavy-ion collisions, gave evidence for structure in the partially damped energy spectra for the Fe + Fe reaction, showed the importance of target-projectile mass asymmetry in governing the evolution of damped reactions, and gave tentative evidence for several new isotopes in the Z = 22 to 26 range. Other experiments utilized the fission-fragment angular correlation technique to determine the linear momentum transfer from projectile to target for ^{16}O reactions in the 8- to 20-MeV/u region and to study simultaneously light-ion spectra (Z = 1 to 8) in coincidence with correlated events. These studies provided a much clearer picture of properties of central and peripheral collisions in heavy-ion reactions, as well as the transition between these two extremes. In addition, problems of Li, Be, and B nucleosynthesis and the relationship of these results to the question of the expanding universe were investigated. Individual sections with significant amounts of information are abstracted separately. (RWR)

HOT-ATOM CHEMISTRY

12262 (COO—3283-28) **Studies in hot atom and radiation chemistry. Progress report, December 1, 1978-November 30, 1979.** Koski, W.S. (Johns Hopkins Univ., Baltimore, MD (USA)). Sep 1979. Contract EY-76-S-02-3283. 21p. Dep. NTIS, PC A02/MF A01.

The cross section for the reaction $Cl^+ (CO,O)CCl^+$ was measured over an energy range from threshold to 18 eV in the center of mass system using a tandem mass spectrometer. The threshold value

yielded a heat of formation of CCl^+ of 15.7 +- 0.1 eV. The angular and energy distribution of the ionic products from the reaction $B^+(^3P/sub\ u/) + D_2$ was also studied at 1 to 40 eV. The product states as determined from the limiting values of the translation exergicity were $BD^+(^3\Sigma^+)$ and $BD^+(^3\pi)$. Velocity contour maps indicated that the former product was probably arising through complex formation whereas the latter was proceeding by a direct mechanism. Work on the reaction $Br^+(D_2,D)BrD^+$ was initiated; both the ground state ^3P and the first excited electronic state (^1D) reactions are being measured. Work was also initiated on the Br-ethane hot atom system. Inelastic and superelastic collisions between rare gas atoms and halogen ions are being investigated. The charge distribution of ^{13}N produced by the reaction $^{12}C(d,n)^{13}N$ over a deuteron energy range of 2.5 MeV to 14 MeV has been measured.

12263 Gas to liquid to solid transition in halogen hot atom chemistry. 6. Product formation routes and chemical selectivity of high energy iodine reactions with butyne isomers. Garmestani, S.K.; Firouzbakht, M.L.; Rack, E.P. (Univ. of Nebraska, Lincoln). Contract EY-76-5-02-1617001. *J. Phys. Chem.;* **83**: No. 22, 2827-2833(1 Nov 1979).

Reactions of recoil produced iodine-128 with isomers of butyne were studied in gaseous, high pressure, and condensed phase conditions, with rare gas additives and in the presence and absence of radical scavengers (I_2 and O_2). It was found that recoil iodine-128 reactions were initiated by thermal electronically excited I^+ species for both 1-butyne and 2-butyne systems. While the diverse and complex nature of the reactions cannot be explained by simple chemical parameters, comparisons among the alkyne systems demonstrate preferential attack of iodine at the triple bond resulting, mainly, in electronically excited intermediates. A comparison of the various product formation routes results in the characterization of general traits common to the alkynes. 6 figures, 4 tables.

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 11319, 12574

12264 (HEDL-SA—1880) **Chemical decontamination of metals.** Partridge, J.A.; Lerch, R.E. (Hanford Engineering Development Lab., Richland, WA (USA)). Oct 1979. Contract EY-76-C-14-2170. 22p. (CONF-791103—66). Dep. NTIS, PC A02/MF A01.

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

A metal decontamination process based upon removal of contamination by treatment with a cerium (IV)-nitric acid solution (or other redox agent in nitric acid) is feasible and highly promising. The technique is effective in dissolving the surface layer of stainless steel. Dissolution rates of approximately 1.5 mils/h were demonstrated with cerium (IV)-nitric acid solutions. Removal of plutonium contamination from stainless steel was demonstrated in laboratory tests, in which activity levels were reduced from greater than 5×10^5 counts per minute to nondetectable levels in approximately one hour at 90°C. Removal of paint from stainless steel surfaces was also demonstrated. Advantages of this process over other chemical solutions include: (1) The solutions are not high salt systems; therefore, there is potentially less waste generated. (2) Cerium(IV) in nitric acid is a good dissolution agent for plutonium oxide. (3) Regeneration of Ce(IV) during the decontamination is accomplished by electrolysis. (4) The process should be effective for irregularly shaped equipment. (5) It could be effective as a spray or a flow-through system. 13 figures.

12265 (ORO—4447-101) **Physical-chemical studies of transuranium elements. Progress report, April 1, 1979-March 31, 1980.** Peterson, J.R. (Tennessee Univ., Knoxville (USA). Dept. of Chemistry). 1980. Contract EY-76-S-05-4447. 26p. Dep. NTIS, PC A03/MF A01.

Major advances in our continuing program to determine, interpret, and correlate the basic chemical and physical properties of the transuranium elements are summarized for the period April 1, 1979 through March 31, 1980. The enthalpy of solution of metallic Am-243 was measured in 1.0 N HCl at 298 K and found to be -621.1 +- 1.6 kJ/mol. The first calorimetric measurements on element 98 were performed by dissolving metallic Cf-249 in dilute HCl. Spectroelectrochemical techniques were applied to a study of the Ce(IV)/Ce(III), Pr(IV)/Pr(III), Tb(IV)/Tb(III), Am(IV)/Am(III), and Cm(IV)/CM(III) couples in aqueous carbonate solution. Pr(IV) and Tb(IV), previously unknown in common aqueous solution, were stabilized in pH-adjusted 5.5 M K_2CO_3 solution. Am(III) was oxidized to Am(IV) and then to Am(V), and solution absorption spectra were obtained. Attempts to oxidize Cm(III) in 5.5 M K_2CO_3 solution were unsuccessful. Anion effects on the sorption of trivalent Am-241 and pentavalent Np-235 on various minerals were investigated. Formation of actinide ion complexes in solution with HPO_4^{2-}, HCO_3^-, SO_4^{2-}, OH^-, and F^- ions increased the sorption of the actinides on the geologic media studied. The particularly enhanced sorption of these actinides onto apatite suggests its use as a component in the backfill material surrounding the nuclear waste containers in a repository.

12266 (PNL-SA—7770) **Decontamination methods.** Perrigo, L.D.; Divine, J.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 23 May 1979. Contract EY-76-C-06-1830. 32p. (CONF-7905131—1). Dep. NTIS, PC A03/MF A01.

From American Society of Mechanical Engineers radioactive waste management course; Alexandria, VA, USA (21 May 1979).

This paper discusses decontamination methods for LWRs. Emphasis is on the chemical cleaning of primary systems and contaminated equipment and components. The equipment is composed primarily of stainless steel, Inconel, Zircaloy, and a few other materials. Variables affecting efficiency are discussed. 10 figures. (DLC)

12267 Enthalpy of formation of uranium hexafluoride. Johnson, G.K. (Argonne National Lab., IL (USA)). *J. Chem. Thermodyn.;* **11**: No. 5, 483-490(May 1979).

The energy of combustion of high-purity uranium in fluorine to form uranium hexafluoride was measured in a bomb calorimeter. The standard enthalpies of formation of crystalline and gaseous UF_6 were derived. The values which are reported, are approximately 11 kJ mol^{-1} more negative than previous measurements based on fluorine calorimetry.

COMBUSTION, PYROLYSIS, AND HIGH-TEMPERATURE CHEMISTRY

12268 (ANL—79-77) **Review and analysis of spray combustion as related to alternative fuels.** Black, C.H.; Chiu, H.H.; Fischer, J.; Clinch, J.M. (Argonne National Lab., IL (USA)). Sep 1979. Contract W-31-109-ENG-38. 44p. Dep. NTIS, PC A03/MF A01.

A review of the literature on spray combustion was conducted, with particular emphasis on theoretical and experimental work on droplet and spray combustion relevant to the use of alternate fuels (mainly liquid fuels derived from coal and shale). Principal differences between coal-derived liquid fuel and petroleum have been identified. Coal liquids have a lower hydrogen-to-carbon ratio, higher aromatic compound content, greater tendency to form soot, and burn with a more luminous flame. Coal liquids pose potential carcinogenic hazards in handling the fuel and from soot resulting from their combustion. Coal liquids are less stable than petroleum, contain considerably more organic nitrogen, produce more NO/sub x/ emissions, hot corrosion of turbine blades, cooling-hole plugging, irregular burning, higher combustor-wall temperatures, greater soot formation, and variability between coal-liquid samples. Although considerable progress has been made in understanding the spray combustion processes of normal petroleum liquids, considerable research work is needed in the area of spray combustion of alternate fuels. Furthermore, the literature indicates that spray combustion of fuels similar to coal liquids is considerably more complex, and that a major research effort is required in anticipation of significant substitution of coal liquids for imported petroleum fuels.

12269 (COO—2944-T1) **Resonance absorption measurements of atom concentrations in reacting gas mixtures. 5. Pyrolysis of C_3H_8 and C_3D_8 behind shock waves.** Chiang, C.; Skinner, G.B. (Wright State Univ., Dayton, OH (USA). Dept. of Chemistry). 1979. Contract EY-76-S-02-2944. 18p. Dep. NTIS, PC A02/MF A01.

Dilute mixtures (5-100 ppM) of C_3H_8 and of C_3D_8 in argon were pyrolyzed behind reflected shock waves at temperatures of 1200 to 1450°K and total pressures of 2-3 atmospheres. Progress of the reaction was followed by analysis for H or D atoms using resonance absorption spectroscopy. Rate constants were determined as follows: $C_3H_8 \rightarrow CH_3 + C_2H_5$, $k_1 = 2.5 \times 10^{16}\exp(-87{,}500/RT)$ s^{-1}; $C_3H_8 + Ar \rightarrow CH_3 + C_2H_5 + Ar$, k/sub 1a/ $= 2.6 \times 10^{21}\exp(-89{,}900/RT)$ $mole^{-1}\ cm^3\ s^{-1}$; where activation energies are in calories. Within experimental error, rate constants for the dissociation of C_3D_8 were the same. 2 figures, 2 tables.

12270 (SAND—79-8807) **Coherent Raman combustion diagnostics.** Mattern, P.L.; Rahn, L.A. (Sandia Labs., Livermore, CA (USA)). 1980. Contract EY-76-C-04-0789. 19p. (CONF-800303—2). Dep. NTIS, PC A02/MF A01.

From 179. national meeting of the American Chemical Society; Houston, TX, USA (23 Mar 1980).

Recently, background-free coherent anti-Stokes Raman scattering and inverse Raman scattering have been used to detect small

(few percent) concentrations of CO in a methane-air flame. This paper reports calculated detectivities for these techniques, as compared with spontaneous Raman scattering, for a broad range of temperature, pressure, and background luminosities.

ENGINEERING

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 12072, 12408

12271 (PNL—3246) **Nondestructive testing of 105mm depleted uranium penetrators.** Morris, C.J.; Foreman, S.J. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Dec 1979. Contract EY-76-C-06-1830. 71p. Dep. NTIS, PC A04/MF A01.

The report is an information update concerning the nondestructive testing (NDT) activities at Pacific Northwest Laboratories (PNL) for depleted uranium penetrator (XM774, XM833) quality inspection and evaluation. This report covers NDT activities from August to November, 1979.

12272 (SAND—79-1209) **Effects of turbulence and delay in activating TIGER II after low altitude release.** Greene, R.W. (Sandia Labs., Albuquerque, NM (USA)). Nov 1979. Contract EY-76-C-04-0789. 25p. Dep. NTIS, PC A02/MF A01.

The effects that specified delays in activating the thrust and control system have on the altitude history of a TIGER-II vehicle released from an F-4 and F-111 were analyzed using a three degree-of-freedom analog simulation. Desirable delay times were identified that would allow acceptable ground clearance when releasing from 100-ft altitude. The effect that atmospheric turbulence had on the vehicle was considered for the defined time delays.

12273 (Y—2195) **Linear-motor drives for machine tools.** Barkman, W.E. (Oak Ridge Y-12 Plant, TN (USA)). 31 Dec 1979. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

Conventional techniques to position moving platforms on precision machines have relied heavily on mechanical drives such as the ball-nut/lead-screw system. Unfortunately, as positioning tolerances become more and more demanding, the cyclic errors-inherent even in precision gear drives-contribute an excessive amount of positioning uncertainty. The linear-motor drive system is one approach to provide a smooth, accurate, vibration-free method for locating a moving platform. Some existing uses of linear motors in industry as well as potential future applications on precision machines are discussed.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 11853, 11857, 11859, 11860, 11861, 11862, 11863, 11864, 11865, 12332, 12333, 12334, 12335, 12336, 12337, 12338, 12351, 12377, 12797, 12833, 12835, 12836, 12838, 12839

12274 (LA—8066-PR) **Magnetic refrigerator development. Progress report, June 1-August 31, 1979.** Barclay, J.A.; Bronson, J.C.; Steyert, W.A. (Los Alamos Scientific Lab., NM (USA)). Dec 1979. Contract W-7405-ENG-36. 8p. Dep. NTIS, PC A02/MF A01.

The report records the progress on the reciprocating magnetic refrigerator project. The annular Dewar for the 9-T magnet has been completed and tested. The apparatus for the first set of experiments has been designed. There is no information on the magnetic wheel refrigerator in the report.

12275 **Operating experience with ESCAR magnet cooling system.** Byrns, R.A.; Eaton, W.F.; Carrieri, J.G.; Gilbert, W.S.; Lambertson, G.R.; Meuser, R.B.; Rechen, J.B.; Schafer, R.V.; Warren, R.P. (Univ of Calif, Lawrence Berkeley Lab). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 103-106(Jan 1979).

The ESCAR magnet cooling system has been successfully demonstrated. This two-phase helium cooling system includes a CTI-Sulzer gas-bearing turbine refrigerator with two-stage compression by oil-lubricated screw compressors, 120 m of 5-cm-diameter vacuum-insulated transfer line and twelve series-connected magnet cryostats with weirs for liquid level control. The refrigeration plant provides up to 1900 w of refrigeration at 4.5 K with a mass flow of 113 g/s. Heat load within the transfer line has been measured at 0.25 w/m in sub-system testing. Cool-down times to 4.5 K for the 12 warm-iron magnets with a cold mass of 2500 kg have been about 12 hours. The magnet cryostats separate the liquid by gravitational extraction and fill in sequence at a rate of up to 400 l/hr. A heater in the transfer line allows adjustment of the inlet coolant quality (ratio of gas to liquid) to the cryostats. Pressure levels in the cold bore, beam orbit space were below $^{-10}$ torr.

12276 **Recovery of a cryostable magnet following a mechanical perturbation: one-dimensional and two-dimensional calculations.** Turner, L.R.; Wang, S.T.; Harrang, J. (Argonne Natl Lab, Ill). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 371-374(Jan 1979).

When a cryostable composite conductor carrying current experiences a heat input from a mechanical perturbation, a normal region develops which initially propagates and then either collapses or continues to propagate. A computer model has been devised to study this phenomenon. The model incorporates initial or continuing heat input from mechanical perturbations, heat conducted to the neighboring elements of the conductor and, if appropriate, heat conducted through insulation to neighboring turns. Heat is transferred to the helium coolant according to a specified heat transfer coefficient. If the element of the conductor is in a normal or current-sharing state, resistive heating also occurs. The (unstable) equilibrium state of heat generation and conduction has been studied; results agree with a static calculation. The model has been validated against experimental measurements of response to heat pulses. A study of the trade-off between cross-sectional areas and wetted perimeter of a conductor is included, with recovery current presented as a function of perturbing energy. 9 refs.

12277 **Superconducting generator technology--an overview.** Edmonda, J.S. (DOE, Washington, DC). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 673-679(Jan 1979).

Application of superconducting technology to field windings of large ac generators provides virtually unlimited field capability without incurring resistive losses in the winding. Several small-scale superconducting generators have been built and tested demonstrating the feasibility of such concepts. For machines of much larger capacity, conceptual designs for 300 Mva and 1200 Mva have been completed. The development of a 300 Mva generator is projected. Designed, engineered and fabricated as a turbo generator, the superconducting machine is to be installed in a power plant, tested and operated in concert with a prime mover, the steam generator and the auxiliary support systems of the power plant. This will provide answers to the viability of operating a superconducting machine and its cryogenic handling systems in a full time, demanding environment. 21 refs.

12278 **MIT-DOE program to demonstrate an advanced superconducting generator.** Smith, J.L. Jr.; Wilson, G.L.; Kirtley, J.L. Jr. (MIT, Cambridge, Mass). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 727-730(Jan 1979).

The objective of the program is to demonstrate improved characteristics for large central station superconducting generators. Based on the EEI-EPRI program at MIT, new concepts have been devised, analyzed and selected for a 10 MVA demonstration machine. The present status of the project is given and the design of the machine is outlined. 13 refs.

12279 **Critical boiling, vapor block, and prospects for control of miniquenches in channel-cooled magnets.** Sydoriak, S.G. (Los Alamos Sci Lab, NM). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 741-743(Jan 1979).

A correlation to ;plus or minus;13% is given for the wide-ranging data of 7 groups who have measured steady-state critical nucleate boiling heat flux, CHF, from a channel wall to helium flowing at known mass flux G. There is no discernible trend in any of the plots of CHF deviation with respect to the six relevant experimental parameters. To achieve quench control in a partially quenched multichanneled magnet, the average mass flux G-bar must exceed G, due to vapor block in the quench-affected channels. Equations are derived for G-bar/G which are based on both laminar and turbulent flow models. In a proposed method of quench control, isolated miniquenches (involving up to one full turn in separate layers of the conductor) are eliminated by a calculable flow of coolant provided by an immersed circulating pump in parallel with the magnet channels. Prospects for success are enhanced by the fact that in typical forced-flow channel boiling, the first (breakaway) and second (recovery) CHF's are reported to be identical, in strong constrast to typical pool boiling. 12 refs.

PROTECTIVE STRUCTURES AND EQUIPMENT

REFER ALSO TO CITATION(S) 12668, 12675

HANDLING EQUIPMENT AND PROCEDURES

REFER ALSO TO CITATION(S) 12301

12280 (ENICO—1008) **Remote maintenance testing, July 1, 1978-June 30, 1979.** Fletcher, R.D. (ed.). (Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)). Oct 1979. Contract AC07-79ID01675. 59p. Dep. NTIS, PC A04/MF A01.

The results of the remote handling and remote maintenance testing at the Remote Maintenance Test Facility (RMTF) from July 1, 1978, through June 30, 1979, are presented. Specific test arrangements and test results from the RMTF of such items as high-efficiency particulate air (HEPA) filter disposal, solids removal equipment, and sample transfer container capper/decapper in support of several projects are discussed.

SHIPPING CONTAINERS

REFER ALSO TO CITATION(S) 11321

12281 (BMI—2039) **Scale model drop tests to evaluate impact response of lead and uranium shielded radioactive material shipping containers.** Hadden, J.A.; Burian, R.J. (Battelle Columbus Labs., OH (USA)). 30 Sep 1979. Contract W-7405-ENG-92. 36p. Dep. NTIS, PC A03/MF A01.

The primary objective of the ongoing program is to develop for DOE/ECT data on and techniques for determining the dynamic impact response of radioactive material shipping container systems for environmental control and safety overview and assessment. Emphasis is placed on lead and uranium shielded radioactive material shipping containers although many of the techniques and results have a general application to the safety evaluation of other energy material shipping container systems, such as those for tritium, fuel cells and LNG.

12282 (BMI—2040) **Validity of scale modeling for large deformations in shipping containers.** Burian, R.J.; Black, W.E.; Lawrence, A.A.; Balmert, M.E. (Battelle Columbus Labs., OH (USA)). 19 Oct 1979. Contract W-7405-ENG-92. 162p. Dep. NTIS, PC A08/MF A01.

The principal overall objective of this phase of the continuing program for DOE/ECT is to evaluate the validity of applying scaling relationships to accurately assess the response of unprotected model shipping containers severe impact conditions -- specifically free fall from heights up to 140 ft onto a hard surface in several orientations considered most likely to produce severe damage to the containers. The objective was achieved by studying the following with three sizes of model casks subjected to the various impact conditions: (1) impact rebound response of the containers; (2) structural damage and deformation modes; (3) effect on the containment; (4) changes in shielding effectiveness; (5) approximate free-fall threshold height for various orientations at which excessive damage occurs; (6) the impact orientation(s) that tend to produce the most severe damage; and (7) vunerable aspects of the casks which should be examined. To meet the objective, the tests were intentionally designed to produce extreme structural damage to the cask models. In addition to the principal objective, this phase of the program had the secondary objectives of establishing a scientific data base for assessing the safety and environmental control provided by DOE nuclear shipping containers under impact conditions, and providing experimental data for verification and correlation with dynamic-structural-analysis computer codes being developed by the Los Alamos Scientific Laboratory for DOE/ECT.

12283 (ORNL—5409/R1) **Safety Analysis Report for Packaging (SARP) of the Oak Ridge National Laboratory TRU Californium Shipping Container.** Box, W.D.; Shappert, L.B.; Seagren, R.D.; Klima, B.B.; Jurgensen, M.C.; Hammond, C.R.; Watson, C.D. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 109p. Dep. NTIS, PC A06/MF A01.

An analytical evaluation of the Oak Ridge National Laboratory TRU Californium Shipping Container was made in order to demonstrate its compliance with the regulations governing off-site shipment of packages that contain radioactive material. The evaluation encompassed five primary categories: structural integrity, thermal resistance, radiation shielding, nuclear criticality safety, and quality assurance. The results of this evaluation demonstrate that the container complies with the applicable regulations.

12284 (PB—294696) **Transportation of radioactive material in Illinois. Report for 6 June 1977-6 June 1978.** (Illinois Dept. of Public Health, Springfield (USA). Div. of Radiological Health). Apr 1979. 30p. NTIS PC A03/MF A01.

Under agreement with the U. S. Nuclear Regulatory Commission and the U. S. Department of Transportation, the State of Illinois engaged in a cooperative program for the surveillance of radioactive material in highway transport within the State. During the first year of the program, from June 6, 1977 to June 6, 1978, ten Illinois State Police troopers monitored the State's highways from time to time in cruisers especially equipped with radiation detection instrumentation. The data collected during the monitoring process are contained in the report. The information relates to personnel radiation exposures, condition of packages, handling practices, and general adherence to regulations governing the transport of radioactive materials.

TRANSPORT AND STORAGE FACILITIES

REFER ALSO TO CITATION(S) 12309

MINING AND DRILLING EQUIPMENT AND FACILITIES

REFER ALSO TO CITATION(S) 11146, 11160

12285 (METC/SP—79/9, pp 185-193) **Design of a mobile horizontal drill.** Jones, E.H.; Thakur, P.C. (CONOCO, Morgantown, WV). Apr 1979.

In Proceedings of the second annual methane recovery from coal beds symposium.

Horizontal boreholes drilled from mine workings are the cheapest and the most effective means of methane drainage in the US coal mines. The design of mobile horizontal drills capable of drilling a 1000-foot long, 4-inch diameter borehole is presented in this study. A mobile rig not only saves time in moving from one site to another but also improves safety and reduces maintenance problems. The mobile horizontal drill described here has been used to drill nearly 3000 feet of horizontal hole on one project. An average drilling rate of 200 feet in an eight hour shift was achieved. Although the design is for relatively thick seams, such as the Pittsburgh seam, many design principles are also applicable to low seams, shaft bottoms, or other places where horizontal drilling may be applicable. Negotiations are currently underway to make this CONOCO development available to the industry as a whole through established equipment manufacturing and marketing organization.

LASERS

12286 (AD-A—063387) **Study on the initial development of high-power millimeter wave sources. Final report.** Read, M.; Lucey, R. (JAYCOR, Alexandria, VA (USA)). 1979. Contract N00173-77-C-0215. 56p. NTIS, PC A04/MF A01.

Under NRL contract number N00173-77-C-0215, JAYCOR has performed an analytic and experimental study of some of the fundamental aspects of cyclotron masers (gyrotrons). In particular, JAYCOR has designed and tested a high power gyrotron oscillator, and has designed and used a gyrotron testing facility. This report discusses the results of this project in detail. The JAYCOR-NRL contract includes the following work statement: (1) Design and test a 200 kw cyclotron maser testing facility which includes the modulator, pulse transformer, power supply, superconducting magnet, and auxiliary subsystems. (2) Design and test maser components to include the RF interaction structure and output coupling network. (3) Design and test the RF instrumentation package to include a millimeter wave calorimetric load and an output mode analyzer. (4) Test and evaluate the magnetron injection gun to be used in the cyclotron maser. Compare measured performance with theoretical predictions and optimize gun performance. (5) Design and test the RF driver package. Essentially this work statement calls for the design of a laboratory for the testing of cyclotron masers and the design and test of the various components of an initial device.

12287 (AD-A—064913) **Laser materials. Final report 1 October 1974-31 December 1977.** Hartman, P.L.; Mahr, H. (Cornell Univ., Ithaca, NY (USA). Lab. of Atomic and Solid State Physics). 25 Oct 1978. Contract N00014-75-C-0248. 9p. NTIS PC A02/MF A01.

After a period spanning over twenty years, ONR support on its Cornell Contract (Present 6N00014-75-C-0248) is being terminated. During that time a great deal has happened in science and in the National Support of Science. Not only has the Office of Naval Research undergone great changes in that time, but so also has the emphasis in this particular area, which ONR has helped to support over this long period of time. It was originally funded as research into the optical properties of alkali halides. Alkali halides at that time was a big area for Cornell solid state physics research. And for a long time that remained the emphasis in the work on the ONR Contract. This gradually changed and during recent years the work has been directed more toward the use of lasers and development in laser technology.

12288 (AD-A—065156) **Selective chemical pumping of electronic states and formation and deactivation processes in electronic transition chemically pumped lasers. Final report 1 September 1974-1 October 1978.** Gole, J.L. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Chemistry; Georgia Inst. of Tech., Atlanta (USA). School of Chemistry). 1978. 114p. NTIS PC A06/MF A01.

A variety of high temperature techniques are applied to the study of visible chemiluminescent phenomena over the pressure range .000001 to 100 torr in order to assess the applicability of several reaction systems for the development of visible chemicals lasers. Efforts have focused on selective formation of excited electronic states, the nature of electronic state interactions and the behavior of these states over a wide pressure range. In studying chemiluminescent spectra, efforts have concentrated on the determi-

nation of activation energies for excited state formation, the determination of excited state quantum yields, the determination of approximate radiative lifetimes for long-lived states, the assessment of rapid energy transfer routes among excited electronic states and the analysis of collisional quenching. Promising systems have been and are being explored in an exploding wire laser system.

12289 (AD-A—065743) **Research in gas lasers. Final report 1 January 31-December 1978.** Morse, T.F. (Brown Univ., Providence, RI (USA). Dept. of Engineering). 1979. 9p. NTIS, PC A02/MF A01.

The work on the rate equation descriptions of pulse propagation in homogeneous media is complete and is being prepared for publication. The pulse duration limit was chosen as long compared to the coherence time so that true coherence effects such as self-induced transparency is absent. However, the system of rate equations are velocity dependent so doppler broadening mechanisms are included. Attempts have continued to determine if it is possible to utilize a plasma break down in air to deduce velocity. Thus far, it has been determined that the magnitude of the scattered signal provides ample signal for short ranges. This technique will prove useful where conventional doppler velocimetry is not possible due to the absence of naturally occurring scattering centers. The density matrix equations for three energy level gases have been formulated. For situations where the pulse or pumping time is longer than a dephasing time, the rate equations explicity contain contributions that are nonlinear.

12290 (AD-A—065885) **Initiation phenomena in pulsed chemical lasers. Final report 8 August 1977-30 September 1978, 18 August-17 November 1978.** Moran, J.P.; Doak, R.B. (Aerodyne Research, Inc., Bedford, MA (USA)). Oct 1978. Contracts N00173-77-C-0222;N00173-78-C-0188. 99p. NTIS, PC A05/MF A01.

It has been proposed that trace addition of ClF_3 to conventional gas mixtures in photo-initiated HF/DF pulsed lasers might substantially improve chain reaction initiation and consequently, system electrical efficiency. It has further been proposed that steady flow of a spatially tailored trace addition of ClF_3 might improve uniformity of initiation and, hence, cavity homogeneity in reptitively pulsed devices by providing enhanced initiation (F-atom production) in regions of diminished lamp illumination. An argon filled flash lamp with pulse duration (FWHM) of approximately 40 microsec was observed to radiate 3.5% of its initial electrical energy in the absorption band of ClF_3 (1750A to 2400A) and 13% of its energy in the absorption band of F2 (2400A to 3400A). Theoretical modeling of flash lamp radiation indicates that short lamp pulses appropriate to pulsed chemical lasers would show equal or better radiation distribution of lamp electrical energy in these absorption bands. The flash lamp was used in photolysis studies which show that absorption of radiation by ClF_3 results in dissociation with efficiency of order unity. Photolytic production of F-atoms could not be determined in the present UV attenuation studies due to the occurrence of a strongly absorbing unidentified photolysis product or products.

12291 (AD-A—065926) **High energy optical resonance transfer laser study. Technical report 24 July-31 December 1978.** Baily, P.; Finzi, J.; Holleman, G.; Hui, K.; Wang, J. (Hughes Aircraft Co., Culver City, CA (USA)). Jan 1979. Contract N00173-78-C-0470,. 73p. NTIS, PC A04/MF A01.

This report describes the first half of an experimental study of the HF laser pumped optical resonance transfer laser (ORTL). Several molecular systems were investigated including HF/HBr, HF/DF, HF/HCl, and HF/HCN as well as the optically pumped HF laser. The latter exhibited the best overall performance in quantitative fluorescence spectroscopy experiments and laser demonstration experiments. New laser systems demonstrated were optically pumped HF, and the HF/DF (3.8 micrometers) and HF/HCN (3.9 micrometers) ORTL systems. Laser oscillation was achieved at pressures ranging from 25 torr to 110 torr. A maximum output power of 20 watts was achieved in the optically pumped HF laser.

12292 (AD-A—066086) **Multistep energy migration and radiationless relaxation processes in phosphor and laser crystals. Final report 1 jan 76-31 dec 78.** Powell, R.C. (Oklahoma State Univ., Stillwater (USA). Dept. of Physics). 31 Dec 1978. 298p. NTIS, PC A13/MF A01.

This report covers the work supported by the US Army Research Office. The research involves the utilization of new laser techniques such as time-resolved site-selection spectroscopy and photoacoustic spectroscopy to characterize multistep energy transfer and radiationless relaxation processes in phosphor and laser materials.

12293 (AD-A—068079) **Studies of the navy-ARPA chemical laser (NACL) exhaust. Final report.** Decorpo, J.J.; Clark, R.C.; Thompson, J.K.; Hudgens, J.W.; Olfky, R.S. (Naval Research Lab., Washington, DC (USA)). 22 Dec 1978. 39p. NTIS, PC A03/MF A01.

Methods have been developed at NRL to sample the NACL exhaust. These methods include particulate, fluoride, and on-line mass spectrometric analysis. The only toxic gases detected were HF and DF. Their concentration in the final exhaust varied between 500 and 10,000 ppm. The particulate matter consisted of iron fluoride and iron oxide. Ten to fifteen percent of the fluorides and 85% of the particulate matter are removed by the pumps.

12294 (AD-A—068190) **Fundamental mechanisms of nonequilibrium mhd lasing phenomena. Final report 1 mar 77-28 feb 78.** Kerrebrock, J.L. (Massachusetts Inst. of Tech., Cambridge (USA). Gas Turbine and Plasma Dynamics Lab.). Dec 1978. Contract F44620-76-C-0067. 396p. NTIS, PC A17/MF A01.

A feasibility study of MHD lasers has been carried out, consisting of a comprehensive numerical modeling and an experimental study of the gain of MHD generator behavior with a three-level model for the CO_2 module which recognizes the lower level energy transfer by CO_2 - CO_2 collisions as the major limiting process. It predicts specific powers as high as 60 ki/kg at efficiencies near 3%. The experimental study has identified He + 0.014 CO_2 + .00001 Cs as the optimum plasma mixture, and verified that 0.3%/cm gain can be attained at a current density of 0.3 amp/cm^2. and electric field of 20V/cm. It has yielded a rate of 3.3 + or - 0.03 x 10^2 for the lower level deactivation.

12295 (AD-A—068387) **Optical-microwave interactions in semiconductor devices. Quarterly report no. 3, 1 Jan-31 Mar 1979.** Figueroa, L.; Slayman, C.; Yen, H.W. (Hughes Research Labs., Malibu, CA (USA)). Apr 1979. Contract N00173-78-C-0192. 38p. NTIS, PC A03/MF A01.

The results of an extensive experimental study of mode locking in semiconductor lasers with different external-cavity configurations are described. The generation of GaAs laser pulses less than 200 psec wide at approximately-GHz repetition rates was achieved by operating the laser in a 5-cm-long external cavity. The presence of a strong resonance at low frequencies in the laser actually aided the generation of short pulses. A novel external-cavity configuration using a piece of optical fiber is also described. Modulation frequencies as high as 4.26 GHz were obtained for lasers biased only slightly above threshold, and optical pulses as narrow as 200 psec were generated using this technique. A theoretical study of the response of GaAs FETs under optical illumination was presented. For a strong photo-transistor effect to occur in an FET requires that the region of active channel under the gate electrode be illuminated. A modified FET design suitable for this purpose is proposed and analyzed.

12296 (AD-A—068495) **Shared aperture breadboard test system (SABTS) laser support. Final report.** Roszhart, T.V.; Ball, W.P.; Sings, J.T.; Schmidt, J.L. (TRW Environmental Engineering Div., Redondo Beach, CA (USA)). Dec 1978. Contract F29601-77-C-0010. 184p. NTIS, PC A09/MF A01.

Deuterium Fluoride (DF) High Energy Laser (HEL) support was provided for testing aperture sharing optical elements in the HEL beam using the Shared Aperture Breadboard Test System (SABTS). The TRW Baseline Demonstration Laser (BDL) HEL facility was modified for SABTS, and laser support was provided for survivability tests of coatings and performance tests of dichroic beam splitters. As an add-on experiment, HEL survivability and performance tests of microwave windows and missile guidance heads were also supported.

12297 (AD-A—068547) **Investigation of transient flow and heating problems characteristics of high energy laser gas circulation systems. Final technical report 8 Aug 1977-31 Mar 1979.** Shih, C.C.; Karr, G.R.; Perkins, J.F. (Alabama Univ., Huntsville (USA). School of Science and Engineering). Mar 1979. Contract DAAK40-77-C-0161. 301p. Availability: Microfiche copies only.

Complementing the Army effort on the Closed Cycle Circulator for repetitively pulsed electric discharge lasers, a project was conducted to develop computer programs modeling the recirculating gas flows in pulsed laser operation including steady and unsteady cases; to perform theoretical analysis of the unstable resonator with tilted spherical mirrors; to conduct an experimental investigation of transient fluid and thermal characteristics of the recirculating flow associated with the pulsed laser operation using a subscale circulator; and to experimentally determine the effects of mufflers, screen packs, and honeycombs on acoustic and thermal waves propagated in the recirculating flow.

12298 (COO—2523-15) **Far infrared chemical lasers. Technical progress report No. 5, September 1, 1978-August 31, 1979.** Robinson, D.W. (Johns Hopkins Univ., Baltimore, MD (USA)). 1979. Contract EY-76-S-02-2523. 5p. Dep. NTIS, PC A02/MF A01.

The intention to use the optically-pumped water vapor laser to study energy absorption and transfer in this triatomic molecule was not realized. The system at this moment is not well-enough understood to be as useful as was originally anticipated. What is known is that laser action in the far infrared is the result of flash-pumping, through suprasil, water vapor in the 10-100 mtorr pressure

range, in a large resonator. About ten lines at about 100-200 cm^{-1} have been found. Four of them very definitely can be assigned to transitions that evolve from the feeding of the level $(001)6_{42}$. The other lines are of dubious assignment or completely unassignable. All of the hundred or so lines of well-known water discharge laser have been assigned to places in the level scheme where the bend-stretch wave functions are mixed.

12299 (COO—4223-7) **Investigation of concept of efficient short wavelength laser. Quarterly progress report, 1 November 1978-31 January 1979.** Krech, R.H.; Piper, L.G.; Pugh, E.R.; Taylor, R.L. (Physical Sciences, Inc., Woburn, MA (USA)). Mar 1979. Contract ES-77-C-02-4223. 16p. (PSI-TR—173). Dep. NTIS, PC A02/MF A01.

A concept for the development of an efficient short wavelength laser based on a class of endoergic molecules-azides is being investigated. The first of two laser-device experiments involves generating high concentrations of azide radicals in the thermal pyrolysis of solid, ionic azides, with the subsequent excitation of the $N_2(B^3\pi/sub\ g/)$ state from azide-radical recombination. Laser action would then take place upon the $N_2(B^3\pi/sub\ g/-A^3\Sigma^+/sub\ u/)$, first-positive transition. The second laser-demonstration experiment involves creating a high density of $NCl(b^1\Sigma^+)$ state by uv photolysis of ClN_3. In this case laser emission is expected on the $NCl(b^1\Sigma^+ \rightarrow X^3\Sigma^-)$ transition at 665 nm.

12300 (LA—7982-MS) **Direct solar pumped laser.** Volkin, H.C. (Los Alamos Scientific Lab., NM (USA)). Jul 1979. Contract W-7405-ENG-36. 33p. Dep. NTIS, PC A03/MF A01.

The direct solar pumped laser described here offers the possibility of drastically reducing the cost of coherent light and greatly enlarging the range of laser applications. Laser operation on the phosphorescence transition $T_1 \rightarrow S_0$ with a suitable dye-solvent system is described. Dye molecules in the ground electronic state S_0 absorb concentrated sunlight in the strong transitions $S/sub\ p/ \leftarrow S_0$ (primarily p = 1). This populates the first excited singlet state S_1 and pumps the first triplet state T_1 via intersystem crossing from S_1. Depending on the dye molecule selected, the optimum laser frequency is in the near infrared or visible. We formulate the set of coupled rate equations that governs the solar pumping kinetics and show that the basic photophysics of our new laser system is compatible with useful cw laser operation. The analysis applies to liquid or solid dye solutions and also to non-rarified dye vapors.

12301 (N—79-19334) **An experimental investigation of $^{235}UF_6$ fission nuclear-pumped lasers. Progress report.** Miley, G.H. (Illinois Univ., Urbana (USA)). Feb 1979. 28p. NTIS PC A03/MF A01.

A UF_6 handling system was designed for use in conjunction with the existing nuclear-pumped laser vacuum system at a nuclear reactor laboratory to perform the experiments described above. A modification to separate the gas fill system from the vacuum system and thus greatly reduce its volume is described as well as operating procedures for the first controlled nuclear pumping experiments with UF_6 vapor contained in the laser cell.

12302 (NTIS/PS—79/0686) **Infrared upconversion (a bibliography with abstracts). Report for 1964-Jun 1979.** Carrigan, B. (National Technical Information Service, Springfield, VA (USA)). Jul 1979. 126p. NTIS PCN01/MF N01.

Studies on device performance, materials, theory, and applications are cited. Tunable lasers, infrared detection, crystal modulators, and frequency converters are included. (This updated bibliography contains 118 abstracts, 14 of which are new entries to the previous edition.)

12303 (PB—293491) **Laser beam profile measurements using spatial sampling, fourier optics, and holography.** Johnson, E.G. Jr. (National Bureau of Standards, Boulder, CO (USA). Electromagnetic Technology Div.). Jan 1979. 96p. NTIS, PC A05/MF A01.

A technique for beam profile measurements at a preselected observation plane was demonstrated, using appropriate holography, lenses, mirrors, and two-dimensional array of small holes to sample the electric field of a laser pulse. This method can measure the amplitude and phase of a laser pulse at each preselected sampling point on a transverse observation plane. Subject to constraints, these measurements can provide separated visual images of the temporal pulse shapes for the amplitude and phase at each of the sampled electric fields. This paper describes the basic concepts for beam profile measurements via holography and uses pictures generated by a prototype system for illustration.

12304 (PB—294049) **Measurement of pulsed-laser power.** Young, M.; Lawton, R.A. (National Bureau of Standards, Boulder, CO (USA). Electromagnetic Technology Div.). Feb 1979. 42p. NTIS, PC A03/MF A01.

The calibration of several optical-pulse power meters to an accuracy of about 8% or better are described. The meters are designed for Q-switched neodymium lasers with peak powers in excess of a few megawatts and pulses longer than five or ten nanoseconds. Combined with a fast oscilloscope or a transient digitizer, the meters display the time-domain waveform of the laser emission and thereby allow determination of parameters such as transition duration (risetime, falltime), duration and peak power. The calibration of the meters by both pulsed and cw methods are described, and it is shown why each method is useful as a check on the other. The effect of speckle on the use of diffusers as attenuators in power meters is treated in some detail.

12305 **Xenon bromide (xebr) excimer laser.** Searles, S.K.; Hart, G.A. US Patent 4,143,336. 6 Mar 1979. Filed date 3 Mar 1976. 4p.

This patent describes a rare gas halide excimer laser in which XeBr is made by an electron-beam. The low lying excited electronic state of the Xe atom generated by the e-beam reacts with Br_2 to produce XeBr which undergoes a bound-free transition with a wavelength of 281.8 nm.

12306 **Volumetric direct nuclear pumped laser.** Jalufka, N.W.; Hohl, F.; DeYoung, R.J.; Williams, M.D. US Patent 4,110,703. 29 Aug 1978. Filed date 19 Apr 1977. 7p.

A volumetric direct nuclear pumped laser was developed in which the gas is a mixture of He-3 and a minority gas from the group of argon, krypton, xenon, chlorine and fluorine. The mixture of He-3 and the minority gas produces lasing with a minority gas concentration of from 0.01 to 10 percent argon, 1 percent krypton, 0.01 to 5 percent xenon and small concentrations of chlorine or fluorine.

12307 (AD-A—068559) **Investigation of non-linear phenomena in solutions of organic dyes and the creation of high-efficiency lasers with frequency tuning based on them.** Shpak, M.T.; Tikhonov, Ye.O. Translated from *Visn. Akad. Nauk Ukr. RSR;* No. 11, 9-19(21 Mar 1978). 20p. NTIS, PC A02/MF A01.

No abstract available.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 11902

12308 (LA—8129-MS) **CONCHAS: An arbitary Lagrangian-Eulerian computer code for multicomponent chemically reactive fluid flow at all speeds.** Butler, T.D.; Cloutman, L.D.; Dukowicz, J.K.; Ramshaw, J.D. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 197p. Dep. NTIS, PC A09/MF A01.

The CONCHAS computer code, which solves the equations of transient multicomponent chemically reactive fluid dynamics in two space dimensions is described. CONCHAS is a time-marching finite-difference code that utilizes a partially implicit numerical scheme and a generalized mesh. Both planar and axisymmetric problems may be solved. Spatial differences are formed with respect to a two-dimensional mesh whose cells are arbitrary quadrilaterals. The location of the cell corners, or vertices, may be arbitrarily specified as functions of time, thereby allowing a Lagrangian, Eulerian, or mixed description. This capability is particularly useful for representing curved and or moving boundary surfaces. Arbitrary numbers of species and chemical reactions are allowed. Discussions are given of the governing equations, the numerical scheme, and the code structure. A FORTRAN listing of the code is also provided.

12309 (LA—8163-MS) **Simulation of tank draining phenomena with the NASA SOLA-VOF code.** Hotchkiss, R.S. (Los Alamos Scientific Lab., NM (USA)). Dec 1979. Contract W-7405-ENG-36. 133p. Dep. NTIS, PC A07/MF A01.

The NASA SOLA-VOF code is a modified version of the SOLA-VOF computer program, specifically designed to calculate the fluid dynamics involved in baffled and unbaffled tank draining problems. It solves the time dependent finite-difference equations that govern the two-dimensional motions of fluids with a free surface upon which surface tension forces can act. The VOF method of tracking the free surface provides an algorithm by which multivalued free surface calculations with surface tension are easily performed. Calculations can be made in either planar or cylindrical geometries with a variety of boundary conditions. The surface tension boundary condition is modeled by an applied surface pressure and wall adhesion effects are specified by a wall contact angle. Complete descriptions are given of the code structure, of procedures for running and setting up the code, of the variables used and of test problems that show the excellent agreement between the calculations and experiments of tank draining problems. A complete computer listing is included in an appendix.

12310 (N—79-20339) **Metastable sound speed in gas-liquid mixtures.** Bursik, J.W.; Hall, R.M. (National Aeronautics and Space Administration, Langley AFB, VA (USA). Langley Research Center). Mar 1979. 54p. NTIS, PC A04/MF A01.

A new method of calculating speed of sound for two-phase flow is presented. The new equation assumes no phase change during the propagation of an acoustic disturbance and assumes that

only the total entropy of the mixture remains constant during the process. The new equation predicts single-phase values for the speed of sound in the limit of all gas or all liquid and agrees with available two-phase, air-water sound speed data. Other expressions used in the two-phase flow literature for calculating two-phase, metastable sound speed are reviewed and discussed. Comparisons are made between the new expression and several of the previous expressions -- most notably a triply isentropic equation as used, a triply isentropic equation as used, among others, by Karplus and by Wallis. Appropriate differences are pointed out and a thermodynamic criterion is derived which must be satisfied in order for the triply isentropic expression to be thermodynamically consistent. This criterion is not satisfied for the cases examined, which included two-phase nitrogen, air-water, two-phase parahydrogen, and steam-water. Consequently, the new equation derived is found to be superior to the other equations reviewed.

12311 (UCID—17275) **User's manual for CNVUFAC, the general dynamics heat-transfer radiation view factor program.** Wong, R.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Jun 1976. Contract W-7405-ENG-48. 77p. Dep. NTIS, PC A05/MF A01.

CNVUFAC, the General Dynamics heat-transfer radiation veiw factor program, has been adapted for use on the LLL CDC 7600 computer system. The input and output have been modified, and a node incrementing logic was included to make the code compatible with the TRUMP thermal analyzer and related codes. The program performs the multiple integration necessary to evaluate the geometric black-body radiaton node to node view factors. Card image output that contains node number and view factor information is generated for input into the related program GRAY. Program GRAY is then used to include the effects of gray-body emissivities and multiple reflections, generating the effective gray-body view factors usable in TRUMP. CNVUFAC uses an elemental area summation scheme to evaluate the multiple integrals. The program permits shadowing and self-shadowing. The basic configuration shapes that can be considered are cylinders, cones, spheres, ellipsoids, flat plates, disks, toroids, and polynomials of revolution. Portions of these shapes can also be considered.

12312 **Hydrocode convergence problem. Part 2.** Hicks, D.L. (Sandia Labs., Albuquerque, NM). Contract AT(29-1)-789. *Comput. Methods Appl. Mech. Eng.;* **20**: No. 3, 303-316(Dec 1979).

In a previous paper a motion compactness theorem was proved for hydrocodes which are simple-conservative and solvable with solutions that are physically acceptable approximations. In this paper it is proved that the above-mentioned conditions are satisfied when the hydrocode scheme is CVNR (conservative modification of von Neumann and Richtmyer's method), the material obeys the ideal gas law, the initial data are physically acceptable, and the boundary values are such that the total volume and total energy remain constant. It follows from the motion compactness theorem that there exists a net of mesh refinements for which CVNR produces a sequentially compact net of approximations to the motion.

12313 **Dispersion measurements in a turbulent boundary layer.** Shlien, D.J.; Corrsin, S. (Johns Hopkins Univ., Baltimore, MD). Contract AT(111)3284. *Int. J. Heat Mass Transfer;* **19**: 285-295(1976).

Dispersion in a turbulent boundary layer was measured in a wind tunnel, downstream of a long heated wire located (successively) at the wall, at 1.66 displacement thickness from the wall, at the position beyond which the intermittency drops below 1.0, and in the intermittent region. Mean temperature profiles approached nearly the same asymptotic shape in all cases. A turbulent Prandtl number was defined that was not far from the Reynold analogy value of 1(0.6 to 0.8). Furthermore, this turbulent Prandtl number was approximately independent of downstream position and showed little variation with source distance from the wall. Mean wall concentrations (temperatures) as a function of downstream distance were fitted with simple power laws. The constant b in Batchelor's theory for the mean particle displacement perpendicular to the wall was calculated from the wall source data, although a basic hypothesis of the theory (anti V $\approx$ constant), was contradicted by the data. The b value agreed closely with the estimates of Ellison and Pasquill. Restrictions of the theory were not satisfied for the other source positions. Comparisons with Poreh and Cermak's measurements (at about the same Reynolds number) showed some areas of agreement.

MATERIALS TESTING

REFER ALSO TO CITATION(S) 11906, 12889

12314 **Internationales symposium qualitaetssicherung. (International symposium quality assurance).** Cologne, Germany, F.R; Verl, TUEV Rheinland (1978). vp. (CONF-780246—).

From International symposium on quality assurance; Bad Neuenahr, F.R. Germany (27 Feb 1978).

A separate abstract was prepared for the individual papers presented at the conference (RCK)

ELECTRONIC CIRCUITS AND DEVICES

12315 (SAND—79-1479C) **Latch-up control in CMOS integrated circuits.** Ochoa, A.; Dawes, W.; Estreich, D.; Packard, H. (Sandia Labs., Albuquerque, NM (USA)). 13 Jul 1979. Contract EY-76-C-04-0789. 13p. (CONF-790706—7). Dep. NTIS, PC A02/MF A01.

From 1979 IEEE Annual conference on nuclear and space radiation effects; Santa Cruz, CA, USA (17 Jul 1979).

The potential for latch-up, a pnpn self-sustaining low impedance state, is inherent in standard bulk CMOS-integrated circuit structures. Under normal bias, the parasitic SCR is in its blocking state but, if subjected to a large voltage spike or if exposed to an ionizing environment, triggering may occur. This may result in device burn-out or loss of state. The problem has been extensively studied for space and weapons applications. Prevention of latch-up has been achieved in conservative design ($\sim$ 9 μm p-well depths) by the use of minority lifetime control methods such as gold doping and neutron irradiation and by modifying the base transport factor with buried layers. The push toward VLSI densities will enhance parasitic action sufficiently so that the problem will become of more universal concern. The paper will surveys latch-up control methods presently employed for weapons and space applications on present ($\sim$ 9 μm p-well) CMOS and indicates the extent of their applicability to VLSI designs.

12316 (SAND—79-1875C) **1024-bit MNOS RAM with inverted CMOS.** Dodson, W.H.; Derbenwick, G.F. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 12p. (CONF-800209—1). Dep. NTIS, PC A02/MF A01.

From IEEE international solid-state circuit conference; San Francisco, CA, USA (13 Feb 1980).

Inverted CMOS control circuitry was used with MNOS memory transistors to build a high-speed nonvolatile 1024-bit RAM with low power and good radiation hardness. 4 figures, 2 tables.

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 11033, 11034, 11188, 11191

12317 (N—79-20266) **Premix fuels study applicable to duct burner conditions for a variable cycle engine. Final report.** Venkataramani, K.S. (General Applied Science Labs., Inc., Westbury, NY (USA)). Dec 1978. Contract NAS3-20603. 44p. NTIS, PC A03/MF A01.

Emission levels and performance of a premixing Jet-A/air duct burner were measured at reference conditions representative of take-off and cruise for a variable cycle engine. In a parametric variation sequence of tests, data were obtained at inlet temperatures of 400, 500 and 600K at equivalence ratios varying from 0.9 to the lean stability limit. Ignition was achieved at all the reference conditions although the CO levels were very high. Significant nonuniformity across the combustor was observed for the emissions at the take-off condition. At a reference Mach number of 0.117 and an inlet temperature of 600K, corresponding to a simulated cruise condition, the NOx emission level was approximately 1 gm/kg-fuel.

UNDERGROUND ENGINEERING

REFER ALSO TO CITATION(S) 11173, 12518

12318 (UCRL—82819) **Continental Drilling for Scientific Purposes Data Management Program.** Howard, N.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1979. Contract W-7405-ENG-48. 12p. (CONF-791156—2). Dep. NTIS, PC A02/MF A01.

From Geological Society of America annual meeting; San Diego, CA, USA (5 Nov 1979).

Lawrence Livermore Laboratory was funded by the Office of Basic Energy Sciences of the Department of Energy to support the establishment of a data and information unit on all DOE drilling activities, as a service for the entire scientific community. The effort is known as The Continental Drilling for Scientific Purposes Data Management Program. The primary concern at this time is the collection of data on basement structures and deep continental basins, thermal regimes of the crust, mineral resources, and earthquakes and faulting. Satisfactory investigation of all these topics is dependent on data from deep and, therefore, expensive holes. An information system for existing and proposed deep drilling projects should be useful both for investigations of the particular concerns noted above and for studies of the earth's crust in general. The data

management program should promote the efficient use of limited funds for drilling deep holes. Given the knowledge of these deep holes, investigators may either use existing information, or propose experiments for planned holes that will - with perhaps only little extra expense compared with the cost of the hole - provide the data they need. The LLL program is intended to improve dissemination of information on scientifically interesting holes. The program is operational but still under development. Data management systems are being reviewed to ascertain the most useful system. Data are being supplied by many individuals knowledgeable about existing and planned deep holes - included among these individuals are members of the staff of the US Geological Survey. Output of data now in the system is available on request. 1 figure, 3 tables.

POLLUTION CONTROL EQUIPMENT

REFER ALSO TO CITATION(S) 11847, 12131

12319 (NTIS/PS—79/0677) **Sulfur dioxide control. Volume 3. 1977-Juneune, 1979 (citations from the ntis data base). Report for 1977-Jun 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Jul 1979. 297p. NTIS PCN01/MF N01.

Report citations cover air pollution control technology and equipment for sulfur dioxide. References are included on emissions reduction, involving fluidized bed combustion, combustion modification and additives, scrubbing, and other flue gas desulfurization processes. Fuel desulfurization and the use of low sulfur fuels are excluded. (This updated bibliography contains 289 abstracts, 148 of which are new entries to the previous edition.)

12320 (NTIS/PS—79/0678) **Sulfur dioxide control (citations from the american petroleum institute data base). Report for 1976-apr 79.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Jul 1979. 216p. NTIS PCN01/MF N01.

This bibliography contains citations on the different aspects of air pollution control of sulfur dioxide by industry. Covered are control processes, techniques, equipment, design, and performance. The updated bibliography contains 210 abstracts, 80 of which are new entries to the previous edition.

12321 (PB—293888) **Application of combustion modifications to industrial combustion equipment (data supplement A). Report for January 1976-January 1978.** Fisher, K.T.; Buening, H.J.; Carter, W.A.; Engel, P.K.; Hunter, S.C. (KVB, Inc., Tustin, CA (USA)). Feb 1979. Contract EPA-68-02-2144. 504p. NTIS, PC A22/MF A01.

The supplement provides raw data from a study of the effects of combustion modifications on air pollutant emissions from a variety of industrial combustion equipment. Tested were 22 units, including refinery process heaters; clay and cement kilns; steel and aluminum furnaces; boilers burning black liquor, woodbark, and CO gas; internal combustion engines; and gas turbine combined cycles. Process variables, fuel types, excess air reduction, burner adjustments, and staged combustion were evaluated primarily for their effect on NOx emissions. Emissions of NOx, SOx, CO, and HC were measured on all units. Emissions of particulate mass and size, trace species, and organics were measured on selected units. This data supplement is intended for researchers who wish to perform their own detailed calculations.

12322 (PB—297643) **Energy efficiencies of air pollution control devices.** Stukel, J.J.; Rigo, H.G. (Illinois Univ., Urbana (USA)). 1974. 20p. NTIS, PC A02/MF A01.

The paper examines the minimum energy requirements for removing gaseous and particulate pollutants from gas streams at various levels of collection efficiency. A comparison of the minimum work with the actual work for typical particulate and SO2 removal systems is presented. Equations for calculating the energy efficiency (effectiveness) of the various control devices are given as a function of both system energy losses and operating and maintenance costs.

12323 (PB—297755) **Fabric filter model sensitivity analysis. Final report Jun 1978-Feb 1979.** Dennis, R.; Klemm, H.A.; Battye, W. (GCA Corp., Bedford, MA (USA). GCA Technology Div.). Apr 1979. Contract EPA-68-02-2607. 214p. NTIS, PC A10/MF A01.

The report gives results of a series of sensitivity tests of a GCA fabric filter model, as a precursor to further laboratory and/or field tests. Preliminary tests had shown good agreement with field data. However, the apparent agreement between predicted and actual values was based on limited comparisons: validation was carried out without regard to optimization of the data inputs selected by the filter users or manufactures. The sensitivity tests involved introducing into the model several hypothetical data inputs that reflect the expected ranges in the principal filter system variables. Such factors as air/cloth ratio, cleaning frequency, amount of cleaning, specific resistence coefficient K2, the number of compartments, and inlet concentration were examined in various permutations. A key objective of the tests was to determine the variables that require the greatest accuracy in estimation based on their overall impact on model output. For K2 variations, the system resistance and emission properties showed little change; but the cleaning requirement changed drastically. On the other hand, considerable difference in outlet dust concentration was indicated when the degree of fabric cleaning was varied. To make the findings more useful to persons assessing the probable success of proposed or existing filter systems, much of the data output is presented in graphs or charts.

RANKINE

REFER ALSO TO CITATION(S) 11144

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

REFER ALSO TO CITATION(S) 12854

12324 **Collective ion acceleration with linear electron beams.** Olson, C.L. (Sandia Labs., Albuquerque, NM (USA). Plasma Theory Div.). pp 1-144 of Collective ion acceleration. Hoehler, G.; Nieksch, E.A. (eds.). Berlin, Germany, F.R.; Springer (1979).

The main topics of this review are basis linear electron beam properties, collective ion acceleration mechanism using linear electron beams, naturally occuring collective ion acceleration processes, collective ion accelerator concepts using linear electron beams and scalable collective ion accelerators using linear electron beams.

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

12325 (BNL—27035) **Electromagnetic interaction of colliding beams in storage rings.** Herrera, J.C. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 13p. (CONF-790318—8). Dep. NTIS, PC A02/MF A01.

From Symposium on nonlinear dynamics and the beam-beam interaction; Upton, NY, USA (19 Mar 1979).

When the beams cross each other in the intersecton region of a storage ring, two distinct effects occur. A particle of one beam may undergo a fundamental interaction with a particle of the other beam. The average number of such events is equal to the product of the machine luminosity and the particle-particle total cross section. It is, of course, these particle interactions which the experimental physicist studies. In contrast to what happens for these fundamental interactions, a particle of one beam passing through the interaction region will always be influenced by the electric and magnetic fields produced by the entire other beam. Clearly, this classical electromagnetic interaction between the two beams will perturb the motion of the particles circulating in the machine. It is the purpose of this paper to present the basic aspects of this beam-particle force. The effect of this electrical force is quite different in the case of continuous (unbunched) proton beams which cross each other at the angle (as in the ISR at CERN and in ISABELLE at Brookhaven), as compared to the case of electron-positron bunches which collide head on (as in the SPEAR II Ring and in PETRA and PEP).

12326 (BNL—27129) **Excitation of higher order modes in Alverez linac structures.** Keane, J.T. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 9p. (CONF-7910122—7). Dep. NTIS, PC A02/MF A01.

From Heavy ion fusion workshop; Berkeley, CA, USA (29 Oct 1979).

The excitation of higher order TM_{01} modes produced during the rf build-up period has been observed and compensated for over the years. Synchronous beam excitation of these modes has not been observed. A possible, though unlikely, mechanism for beam excitation has been presented. This would occur only in a very specific section of the machine (low beta). There is no strong reason to expect poor beam quality for currents near 160 milliamperes but further studies into the effect of heavy beam loading should be pursued.

12327 (BNL—51094) **MEQATRON: a high-power high-frequency rf source.** Maschke, A.W. (Brookhaven National Lab., Upton, NY (USA)). 28 Sep 1979. Contract EY-76-C-02-0016. 11p. Dep. NTIS, PC A02/MF A01.

MEQATRON is an acronym for a multiple-beam electrostatic-quadrupole-focused array of electron beams. Conventional electron beam devices consist principally of single electron beams. In

this paper the single-beam space-charge limitations are discussed, and a relationship for power flux (W/m^2) is obtained. Several features of the multiple-beam approach become clear at once. Because the multiple-beam approach removes the current limitation on performance, it is possible to design high-current low-voltage tubes. This fracture is important for low-frequency (200 MHz, say) klystrons. Another feature of the multiple-beam approach relates to the very small sizes (1 to 2 mm, say) associated with each beam. This offers the possibility of developing high-power rf sources in the millimeter wavelength region.

12328 (BNL—51119) **Formulary for MEQALAC design.** Maschke, A.W. (Brookhaven National Lab., Upton, NY (USA)). 27 Nov 1979. Contract EY-76-C-02-0016. 6p. Dep. NTIS, PC A02/MF A01.

From the space-charge limits for quadrupole transport systems discussed in an earlier report, some simple relations are obtained that will assist in the design of practical systems.

12329 (LA-UR—80-309) **Emittance growth in rf linacs.** Jameson, R.A. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 11p. (CONF-7910122—5). Dep. NTIS, PC A02/MF A01.

From Heavy ion fusion workshop; Berkeley, CA, USA (29 Oct 1979).

As the space-charge limit is approached, the current that can be accelerated in an rf linac and the output emittance that can be expected are discussed. The role of the envelope equations to estimate limits is outlined. The results of numerical experiments to explore general properties of emittance growth are given.

12330 **Further theoretical studies of the beam breakup instability.** Neil, V.K.; Hall, L.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.); Cooper, R.K. *Part. Accel.;* **9**: No. 4, 213-221(Jun 1979).

The beam breakup instability in linear accelerators is investigated theoretically. A somewhat restricted model of the beam-transport system is used. With this model, it is possible to treat the instability analytically and obtain an expression for the amplitude of transverse coherent oscillations as a function of time at any position in the machine, taking external focusing into account exactly. The theory is directly applicable to linear induction accelerators in which a solenoidal beam-transport system is employed. It may also be used to obtain approximate analytic results for an rf linac consisting of side-coupled cavities and utilizing quadruple focusing.

AUXILIARIES AND COMPONENTS

12331 (SLAC-PUB—2443) **SAMAC program: the computer support for a stand-alone monitoring and control system.** Logg, C.A. (Stanford Linear Accelerator Center, CA (USA)). Dec 1979. Contract EY-76-C-03-0515. 12p. (CONF-791215—5). Dep. NTIS, PC A02/MF A01.

From DECUS 1979 fall symposium; San Diego, CA, USA (10 Dec 1979).

The high energy physics experiments at SLAC require constant monitoring and control of the numerous components contained in the particle detection apparatus. This paper describes a basic hardware configuration and operating system which have been designed and implemented to satisfy the monitoring and control requirements of the many different setups used in these high energy physics experiments. It is based on the LSI-11 microprocessor with up to one million words of RAM and EPROM which are interchangeably mappable into the normal LSI-11 RAM/EPROM address space of 28K words. The entire system is modular in hardware and software so that it can easily be tailored to an individual experiment. The human interface is such that little training is required for effective use of the system.

12332 **Support and cryostat system for doubler magnets.** Biallas, G.; Finks, J.E. Jr.; Strauss, B.P.; Kuchnir, M.; Hanson, W.B.; Kneip, E.; Hinterberger, H.; DeWitt, D.; Powers, R. (Powers Assoc Inc). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 131-133(Jan 1979).

The support design, performance and mass production engineering of the dipole magnet cryostat for the Fermilab Energy Doubler/Saver are described. The coils, which are surrounded by a warm iron yoke, must be supported against high magnetic forces resulting from errors in the concentricity between the coil and iron yoke. The whole support system must be further contained within a one inch radial distance. The support system developed to meet these criteria, which is a combination of heat-sunk G-11 blocks, meets the requirement of total helium heat leak of 5 w per magnet. Data are presented on both mechanical and thermal performance. The unique quality assurance system used by both industrial and Fermilab fabricators is discussed.

12333 **Room temperature field measurements of superconducting magnets.** Peters, R.E.; Harris, L.; Saarivirta, J.M.; Tollestrup, A.V. (Fermi Natl Accel Lab, Batavia, Ill). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 134-136(Jan 1979).

During the production of the superconducting magnets for the Fermilab Energy Doubler/Saver, it is important to monitor the magnetic field quality. Since it is both costly and time consuming to delay these measurements until after each magnet has been placed in a cryostat, a room temperature measurement system was developed which is capable of resolving a $\Delta B/B$ smaller than 1×10^{-5}.

12334 **Production measurement of energy doubler magnets.** Gross, D.A.; Wake, M.; Yamada, R.; Blatchley, D.; Price, M.E. (Fermi Natl Accel Lab, Batavia, Ill). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 137-140(Jan 1979).

Measurements are reported of 50 energy doubler dipoles and 6 quadrupoles using a facility which currently averages complete measurements of 5 magnets a week. Dipoles are 22 feet long with 3 inch diameter beam bore and produce a full field of 4.5T at 4500A. Quadrupoles are 7 feet long and produce a field gradient of 99T/m. in the energy doubler; 4.23T corresponds to 100 GeV. Magnets are measured individually for quench behavior, training, ac loss, harmonic content, integral field (gradient) length, vertical plane, and longitudinal field homogeneity.

12335 **Ac loss in energy doubler magnets.** Wake, M.; Gross, D.; Yamada, R.; Blatchley, D. (Fermi Natl Accel Lab, Batavia, Ill). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 141-142(Jan 1979).

A computerized ac loss measurement system was developed, and more than 50 magnets were measured. The ac losses depended on various factors, such as conductor surface and pressure applied to coil windings. Statistical correlation between quench current and ac loss is shown. From the measurements of magnets made of different kinds of cables, most of the eddy current loss was found to be in the inner coil of the double layer structure. Among three kinds of eddy current loops, the one which comes from the interconnection between crossing strands was proved to be the major part. Such an eddy current can be almost eliminated by the use of a copper oxide resistive layer between strands. Thus, the Energy Doubler/Saver magnets will be operated up to 4.5T with a loss of about 450J/cycle per each dipole magnet. To estimate real time power loss instead of total loss throughout the whole cycle, a new method was tried and successful results were obtained.

12336 **Progress report--Fermilab energy doubler.** Tollestrup, A.V. (Fermi Natl Accel Lab, Batavia, Ill). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 647-653(Jan 1979).

Since a previous report made in 1976, over 100 22-foot long coils has been constructed and studied. About 50 complete magnets have been constructed by techniques that routinely turn out 5 magnets/week and can be expanded to 8/week. The tooling can be easily duplicated. A quadrupole has been developed and tested using the same mass production techniques as used for dipole, and a production line is coming into operation. A string of twenty-five magnets have been installed in the main ring tunnel and is undergoing cryogenic and beam transport tests at 100 Gev. A magnet test facility has been constructed using a 1500 W refrigerator that has six stations available for cooling and testing complete magnets. This facility will provide complete tests of the field quality and the cryostat, before each magnet is installed.

12337 **Fermilab doubler magnet design and fabrication techniques.** Koepke, K.; Kalbfleisch, G.; Hanson, W.; Tollestrup, A.; O'Meara, J.; Saarivirta, J. (Fermi Natl Accel Lab, Batavia, Ill). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 658-661(Jan 1979).

During the last year, the Fermilab doubler magnets have benefited from a development effort to upgrade the performance of the superconducting magnets. This paper presents the results of this effort. The design philosophy and the fabrication techniques used on current magnets are discussed, along with innovative laminated tooling which has been designed to give Fermilab a two dipole a day production capability. Specific topics discussed are coil geometry, coil winding techniques, coil clamp collars, buss geometry and insulation, integral quench heaters for quench protection, coil twist, coil helium irrigation and assembly techniques that assure azimuthal preload and accurate coil size.

12338 **Design, construction, and operation of 12 ESCAR bending magnets.** Lambertson, G.; Borden, A.; Cox, J.; Eaton, W.; Gilbert, W.; Holl, J.; Knight, E.; Main, R.; Meuser, R.; Rechen, J.; Schafer, R.; Toby, F.; Voelker, F. (Univ of Calif, Lawrence Berkeley Lab). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 662-665(Jan 1979).

The goal of the ESCAR (Experimental Superconducting Accelerator Ring) Project was to build and operate a small, state-of-the-art, rapid-pulsing proton synchrotron using superconducting magnets. The magnetic field quality and beam tube vacuum had to be sufficiently good to permit operation as a storage ring for high current beams. The interacting systems aspects involved in a complete cryogenic accelerator were felt to be as challenging and

important as the development of reproducible high-performance superconducting magnets. Design work started in 1974, and twelve bending magnets, half of those required for the final accelerator, were installed at the accelerator site in November, 1977. The installed magnets were operated in a series of systems tests between November, 1977, and June, 1978.

ION SOURCES

REFER ALSO TO CITATION(S) 12063

12339 (BNL—26881) **Properties of H^- and D^- beams from magnetron and Penning sources.** Sluyters, T.; Kovarik, V. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 8p. (CONF-790927—34). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

The quality of negative hydrogen isotope beams are evaluated after extraction from magnetron and Penning sources. The general conclusions of these measurements are that: (a) the beam quality from these plasma sources are adequate for the transport of high current negative ion beams in bending magnets; (b) there is evidence of practically complete space charge neutralization in the drift space beyond the extractor; (c) the beam performance from the Penning source appears to be better compared with the magnetron source; and (d) it is likely that the high electric field gradient and a concave ion emission boundary are responsible for a beam cross-over near the anode aperture, which causes beam divergence practically independent of the extraction geometry.

EXPERIMENTAL FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 12327

12340 (BNL—26962) **Linac for the National Synchrotron Light Source.** Batchelor, K.; Bittner, J.; Dickinson, T.; Racaniello, V.; Sheehan, J. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 7p. (CONF-790927—35). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

The nominally 100 MeV electron linear accelerator to be used as an injector for the booster synchrotron of the National Synchrotron Light Source is described. The machine utilizes a combination of Varian and SLAC accelerating guides and is interfaced by means of a microprocessor-based Intel Multibus system, to the Data General central control computer. Provision for emittance and momentum measurement is provided in the transport line between the linac and the booster synchrotron.

12341 (BNL—27004) **Report of workshop on Windowless Gas Phase Beam Line at the National Synchrotron Light Source, June 29, 1979.** Grover, J.R.; Klemm, R.B.; Mitchell, J.B.A. (eds.). (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 41p. Dep. NTIS, PC A03/MF A01.

A workshop was held on the 29th June 1979 to present the design of the Windowless Gas Phase Beamline for the National Synchrotron Light Source and to discuss the proposed research to be performed using this equipment. Participants included scientists from the Brookhaven National Laboratory, Oak Ridge National Laboratory, Yale University, the University of Rochester, and United Technologies Research Center. The report summarizes the presentations that were made and also includes contributions from scientists who were unable to attend.

12342 (BNL—27030) **Overview of colliding beam facilities.** Herrera, J.C.; Month, M. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 28p. (CONF-790318—7). Dep. NTIS, PC A03/MF A01.

From Symposium on nonlinear dynamics and the beam-beam interaction; Upton, NY, USA (19 Mar 1979).

A review is presented of the colliding beam facilities in existence today. The major high energy physics facilities around the world are described, and a view is presented of the beam collisions in which the instruments used to make the beams collide and those used to detect the products of particle interactions in the beam overlap region are described. (GHT)

12343 (BNL—27128) **Description of the M1 MEQALAC and operating results.** Adams, R.; Boruch, J.; Bertsche, A. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 22p. (CONF-7910122—6). Dep. NTIS, PC A02/MF A01.

From Heavy ion fusion workshop; Berkeley, CA, USA (29 Oct 1979).

MEQALAC stands for Multiple Electrostatic Quadrupole Array Linear Accelerator. The first model, M1, was designed, built, and tested in a three month period from July to October 1979. Within a week of operation a Xenon output current of 85% of the calculated space-charge limit was obtained. In the following sections, the M1 components and operation are described. Some of the design choices were made to allow hand-fabrication with available tools (principally a table-top lathe and a table-top drill press), while others were influenced by the ion source development at hand. The major goal was to demonstrate the MEQALAC principle of accelerating multiple beams through arrays of strong focussing electrostatic quadrupoles. Xenon was used since it demonstrates the principles of a low beta linac as needed for the Heavy Ion Fusion program, without the complications of a heavy-metal ion source.

12344 (CONF-790743—9) **Heavy-ion-linac post-accelerators.** Bollinger, L.M. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 39p. Dep. NTIS, PC A03/MF A01.

From Symposium on heavy ion physics from 10-200 MeV/A; Upton, NY, USA (16 Jul 1979).

The main features of the tandem-linac system for heavy-ion acceleration are reviewed and illustrated in terms of the technology and performance of the superconducting heavy-ion energy booster at Argonne. This technology is compared briefly with the corresponding technologies of the superconducting linac at Stony Brook and the room-temperature linac at Heidelberg. The performance possibilities for the near-term future are illustrated in terms of the proposed extension of the Argonne booster to form ATLAS.

12345 (CONF-7909111—1) **History of the polarized beam.** Parker, E.F. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 17p. Dep. NTIS, PC A02/MF A01.

From Symposium on the history of the ZGS; Argonne, IL, USA (13 Sep 1979).

In 1973, the first high energy polarized proton beam was developed at the Argonne Zero Gradient Synchrotron (ZGS). It operated very successfully and productively until 1979 when the ZGS was shut down permanently. This report describes the development, characteristics, and operations of this facility.

12346 (COO—2114-38) **Elementary particles and high energy phenomena. Progress report, January 1979-December 1979.** Bartlett, D. (Colorado Univ., Boulder (USA). Dept. of Physics and Astrophysics). Jan 1980. Contract EY-76-C-02-2114. 18p. Dep. NTIS, PC A02/MF A01.

The experimental program in 1979 was directed toward the preparation of two major detectors: the new multiparticle spectrometer facility for the Fermilab tagged photon beam and the lepton/total energy detector (MAC) for PEP. The two large Cerenkov counters were installed and made operational during a test beam run at Fermilab and substantial progress was made on the track reconstruction programs. The MAC central drift chamber was completed and delivered at SLAC and operational tests were started. Work produced by the theory group included studies of color separation in multi-hadron jet production, diffractive jet production in photo-induced reactions, the relation between the several generations of leptons and quarks, tests of unified gauge theories, gauge hierarchies, and several problems in grand unified theories.

12347 (LA—8109-MS) **Ice targets.** Pacheco, C.; Stark, C.; Tanaka, N.; Hodgkins, D.; Barnhart, J.; Kosty, J. (Los Alamos Scientific Lab., NM (USA)). Dec 1979. Contract W-7405-ENG-36. 10p. Dep. NTIS, PC A02/MF A01.

This report presents a description of ice targets that were constructed for research work at the High Resolution Spectrometer (HRS) and at the Energetic Pion Channel and Spectrometer (EPICS). Reasons for using these ice targets and the instructions for their construction are given. Results of research using ice targets will be published at a later date.

12348 (LA-UR—80-310) **Summary of low-β linac working group.** Jameson, R.A. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 9p. (CONF-7910122—4). Dep. NTIS, PC A02/MF A01.

From Heavy ion fusion workshop; Berkeley, CA, USA (29 Oct 1979).

A summary is presented of the feasibility studies of using multiple linacs at the low-β end with funneling of the ion beams to a single linac as beta increases. (GHT)

12349 (LA-UR—80-342) **rf linac approach to heavy ion fusion.** Swenson, D.A. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 7p. (CONF-7910122—3). Dep. NTIS, PC A02/MF A01.

From Heavy ion fusion workshop; Berkeley, CA, USA (29 Oct 1979).

The necessary properties of funneling particle beams from multiple accelerators into combined beams having higher current are outlined, and methods are proposed which maximize the efficiency of this process. A heavy ion fusion driver system example is presented which shows the large advantages in system efficiency to be gained by proper funneling.

12350 Stopped muon channel at LAMPF. Thompson, P.A.; Hughes, V.W.; Lysenko, W.P.; Vogel, H.F. (Los Alamos Scientific Lab., NM (USA)). *Nucl. Instrum. Methods;* **161**: No. 3, 391-411(15 May 1979).

A stopping muon beam has been constructed at LAMPF. This channel operates in the momentum range of 25-250 MeV/c. Peak stopping rates are 1.5 X 10^4 μ^-/(μA s g/cm^2) and 7 X 10^6 μ^+/(μA s g/cm2). Contamination levels are exceptionally low: less than 0.5% for electrons and less than 0.1% for pions. A separated 'surface' beam has been developed with stopping densities as high as 3 X 10^6 μ^+/(μA s g/cm^2). Details are given of design calculations construction and measurements on the completed beam line.

12351 Design, fabrication and performance of low current superconducting beam line dipole. Cox, B.; Dillmann, T.; Garbincius, P.H.; Kula, L.; Mazur, P.O.; Satti, J.A.; Skraboly, A.; Tilles, E. (Fermi Natl Accel Lab, Batavia, Ill). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 126-127(Jan 1979).

A low current superconducting coil intended for use in a beam transport dipole magnet was built and tested. The coil design, fabrication, quench protection, and tests results are presented.

STORAGE RINGS

REFER ALSO TO CITATION(S) 12342, 12375

INSTRUMENTATION

RADIATION INSTRUMENTATION

12352 Segmented calorimeter: a study of hadron shower structure. Sessoms, A.L.; Goodman, M.S.; Holcomb, L.; Sadowski, E.S.; Strominger, A. (Harvard Univ., Cambridge, MA (USA). Dept. of Physics); Eisenstein, B.; Holloway, L.E.; Wroblicka, W.T. (Illinois Univ., Urbana (USA). Dept. of Physics); Wright, S.C. (Chicago Univ., IL (USA). Enrico Fermi Inst.); Kephart, R.D. (Fermi National Accelerator Lab., Batavia, IL (USA)). *Nucl. Instrum. Methods;* **161**: No. 3, 371-382(15 May 1979).

The construction, operating characteristics and use of a large segmented liquid argon/iron ionization calorimeter is described. With this instrument the authors have carried out qualitative studies of the development of hadronic showers at high energies. Results on both the longitudinal and transverse development of showers are given. The energy of an incident hadron can be determined with a resolution of: sigma sub(E)/E = (8.5 + 28/$\sqrt{}$Esub(H))%, and its dierction with a resolution of: sigmasub(theta) = (16 + 433/Esub(H)) mrad.

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 11894, 12394, 12479, 12574, 12576

12353 (COO—1671-78) **Theory of RBE. Progress report, 1 January-31 December 1978.** Katz, R. (Nebraska Univ., Lincoln (USA)). Sep 1978. Contract EY-76-S-02-1671. 13p. Dep. NTIS, PC A02/MF A01.

The shapes of the blackness-exposure curves of special nuclear emulsions after exposure to x-rays of 15-150 kvp have been found to remain constant, at all applied voltages. Since the shapes of these curves mimic those of biological cells (for cell killing vs. exposure), no change is expected in the RBE of low LET radiations at low dose levels. This finding disagrees with radiobiological findings in which the RBE of gamma-rays relative to x-rays increased at low dose, and was expected to approach 4. A minimal model of a heavy ion beam incorporating secondary and tertiary particle production has been constructed, in support of our investigations of relative effectiveness. The model gives good agreement with depth-dose curves from He to Ar for 8-30 cm of penetration in water. When applied to the survival of T-1 kidney cells using the parameters of the theory of RBE assigned from earlier work and slightly modified to accomodate recently attained levels of hypoxia, good agreement is found with measured values of the RBE and OER in Ar beams, for these cells. Secondary particle distribution alters the depth dose distribution dramatically, but has a much smaller effect on these biological parameters. To illustrate the potential application of the model to heavy particle therapy, we have designed a ridge filter, and find once again that it will be impossible to achieve isoeffect volumes for both oxic and hypoxic cells in a single port irradiation. Where possible, the preferred mode for heavy ion therapy must be symmetric cross-firing, where it is relatively simple to achieve isoeffect volumes for both oxic and hypoxic cells.

12354 (UCD—472-125, pp 165-167) **Automatic sample changer and microprocessor controlled data router for a small bulk-sample counter.** Parks, N.J.; Schwind, J.A.; Hinz, E.A. Oct 1979.

In Annual report, 1978-1979.

We have designed a gamma-ray counting system for small bulk-samples that incorporates an automatic sample-changer and multiple data-output device. The system includes an inexpensive microprocessor and is constructed mainly of materials and equipment commonly available at most institutions engaged in nuclear research.

12355 Pulse pileup effects on plasma electron temperature measurements by soft X-ray energy analysis. Dyer, G.R.; Neilson, G.H.; Kelley, G.G. (Oak Ridge National Lab., TN (USA)). *Nucl. Instrum. Methods;* **161**: No. 3, 365-370(15 May 1979).

The electron temperature of hot plasma is convenintely derived from bremsstrahlung spectra obtained by pulse-height analysis using a lithum-compensated silicon detector. Time-resolved temperature measurements require high counting rates, with ultimate rate limited by pulse pileup. To evaluate this limit, spectral disorted spectra are derived as functions of Maxwellian temperature and pileup fraction for both square and triangle pulse shapes. A comparison of temperatures obtained from distorted spectra with actual values indicates that measurements with less than 10% error can be made in the absence of line radiation, even from spectra containing 40% pileup.

12356 Constrained model-based representations of X-ray detector efficiency curves. Cipolla, S.J. (Creighton Univ., Omaha, NE (USA)); Gallagher, W.J. (Massachusetts Inst. of Tech., Cambridge (USA). Francis Bitter National Magnet Lab.). *Nucl. Instrum. Methods;* **161**: No. 1, 161-162(15 Apr 1979).

Campbell, Jorch and Thompson have corroborated the reliability of a model-based efficiency function proposed by the present authors (1974,6) by applying it to their Si(Li) and Ge(Li) X-ray detectors. In the process, they did encounter a difficulty in fitting the model to the Ge(Li) detector data. The source of this difficulty is traced to unrealistic parameter signs, and its possible reoccurrence is eliminated by a simple modification of the model equation.

12357 Measurement of the ionization loss in the region of relativistic rise for noble and molecular gases. Walenta, A.H.; Fischer, J.; Okuno, H.; Wang, C.L. (Brookhaven National Lab., Upton, NY (USA)). *Nucl. Instrum. Methods;* **161**: No. 1, 45-58(15 Apr 1979).

The ionization loss of relativistic charged particles has been measured in thin samples of Ar, Xe, and propane in a pressurized gas proportional counter. Although the total relativistic rise becomes smaller for increasing pressure, the reduced fluctuation of the ionization loss permits, in principle, a better particle separation. Propane is found, especially in the lower pressure range, to give better particle separation at the expense of restriction to smaller momenta in comparison to Ar and Xe. An attempt is made to describe the relativistic rise and particle identification by simple gas parameters using Sternheimer's approximation.

12358 Monte Carlo study of the scanning problem with a visibility distribution. Cochrane, J.; Gieraltowski, G.F.; Hyman, L.G. (Argonne National Lab., IL (USA)). *Nucl. Instrum. Methods;* **160**: No. 3, 503-510(1 Apr 1979).

The authors summarize the results of a Monte Carlo study of the random scanning problem. In this study, allowance is made for the possibility that some events may be more difficult to detect than others. Several estimators are compared under a variety of conditions. This work may be used as guide to the optimum strategy for scanning an experiment.

12359 Impurity monitor for liquid ionization chamber media. Gruhn, C.R.; Maier, W.B. II (Los Alamos Scientific Lab., NM (USA)). *Nucl. Instrum. Methods;* **160**: No. 1, 55-60(1 Mar 1979).

Impurities dissolved in liquid ionization chamber media are monitored by infrared absorption spectroscopy. Detection of low levels (ppm-ppb) of impurities is demonstrated.

12360 Bulk etch rate studies of cellulose nitrate particle track detectors. Harris, M.J.; Schlenker, R.A. (Argonne National Lab., IL (USA)). *Nucl. Instrum. Methods;* **160**: No. 1, 159-163(1 Mar 1979).

Bulk etch rates are reported for LR 115, Type II and for CA 80-15 cellulose nitrate particle track detectors. The etching conditions were 2.5 N NaOH at 60°C without stirring. The data show an apparent increase in the bulk etch rate of LR 115, Type II, as etching time increases from 5 to 75 min. A comparison is made between these values and those from other laboratories.

12361 Analysis of self-powered gamma ray detector with directional discrimination. Levert, F.E.; Beyerlein, R.A.; Cox, S.A. (Argonne National Lab., IL (USA)). *Nucl. Instrum. Methods;* **160**: No. 1, 61-72(1 Mar 1979).

The results of a combined Monte Carlo simulation and experimental investigation of the directional and energy dependent response of a self-powered gamma detector with a flat plate Pb-C

central electrode are presented. The electron yield of the central electrode in a three dimensional mockup of the detector was calculated for photons of several discrete energies, emanating from an infinitely thin planar source, incident on the outer surface of the detector. Separate computations were done with the source facing the lead side and carbon side of the central electrode. Experimental measurements with a detector that closely matched the design used in the simulation were conducted in a graphite column next to a neutron leakage face of a low flux reactor. A localized gamma ray source was created by positioning a ^{235}U strip between the leakage face of the reactor and the detector. A comparison of results obtained in both cases showed good agreement. Also experimental measurements to determine the effect of the thickness of lead shielding surrounding the outer wall of the detector and space charge in the vacuum insulator between the central electrode and the inner wall on the response of the detector were performed.

12362 Electron detection efficiency of a NaI(Tl) scintillator for electrons and for gamma rays above a few keV. Freedman, M.S.; Beery, D.A.; Porter, F.T. (Argonne National Lab., IL (USA)). *Nucl. Instrum. Methods;* **159**: No. 2-3, 497-512(15 Feb 1979).

A technique is developed for the analysis of photoelectron pulse amplitude distributions from gamma rays or electrons of selected energy observed with a GaP first dynode photomultiplier, taking into account the time-spread of photon emission from the NaI(Tl) scintillator. The observed amplitude distribution is decomposed into a unique sum of experimentally based, constructed amplitude distributions (with relative intensities fsub(n)), one for each number n of photoelectrons emitted in each detected event. It is experimentally verified that for unique energy deposition in the scintillator, the pulse amplitude distribution gives rise to a number distribution fsub(n), and also that the loss of detected events above a very low discrimination level is accurately given by the Poisson prediction for events whch fail to release even one photoelectron, i.e., Psub(m) (0). For a spectrum of energies actually deposited in the crystal due to various degrees of backscattering of an impinging electron with given energy, the derived fsub(n) distribution below n = 10 is analyzed into a quasi continuum of weighted Poisson distributions. The efficiency loss for any given discrimination level can be obtained from this continuous function. The method is shown to work down to an intrinsic detection efficiency of 10% for very low energy gamma rays and down to at least 5 keV for electrons. Reasons for disagreement between observation and expectation in the range 2.6-5 keV for electrons are discussed.

12363 X-ray streak camera electrode design using a plasma simulation code. Gitomer, S.J.; Hall, W.S. (Los Alamos Scientific Lab., NM (USA)). *Nucl. Instrum. Methods;* **159**: No. 2-3, 331-335(15 Feb 1979).

A two dimensional electrostatic particle-in-cell plasma simulation code has been used to follow the motion of a beam of photoelectrons generated in an X-ray streak camera. Design criteria have been developed which enable one to find optimum sweep electrode configurations given external constraints such as physical dimensions of the streak camera, and amplitude and time dependence of applied streak voltages. Performance of the design incorporated into a prototype streak camera is evaluated in the presence of transverse velocity dispersion in the photoelectron beam. Aprroximately 2 ps resolution is predicted from the simulations for the prototype streak camera in agreement with experiment. Subpicosecond resolution should be possible in future version of the device.

12364 Development of the semiconductor radiation detector. McKenzie, J.M. (Sandia Labs., Albuquerque, NM (USA)). *Nucl. Instrum. Methods;* **162**: No. 1-3, 49-73(1979).

The author presents an historical review of semiconductor detectors in which he acknowledges the individuals, examines their motivation and recreates the environment which made the rapid development of semiconductor detectors possible.

RADIATION DOSEMETERS

REFER ALSO TO CITATION(S) 12353, 12395, 12503

12365 (CONF-791049—23) **Gamma spectrometry and calibration methods used in neutron dosimetry.** Malewicki, R.L.; Heinrich, R.R.; Popek, R.J. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 11p. Dep. NTIS, PC A02/MF A01.

From 23. conference on analytical chemistry in energy technology; Gatlinburg, TN, USA (9 Oct 1979).

Neutron activation rates are calculated from measured gamma-ray spectral data obtained from calibrated lithium drifted germanium [Ge(Li)] detectors. The calibration techniques, which include energy, efficiency, pulse height analyzer data reduction, and geometry factors, are discussed. Problems encountered when analyzing highly radioactive samples, specifically random coincidence summing, sample size, air absorption, and use of absorbers, are also discussed briefly. To illustrate the accuracy achievable, the reduction of gamma-ray spectral data and the calculation of reaction rates by three independent laboratories are presented for both fission and nonfission foils to a precision of +-1 to 2% (1σ). The application of these neutron activation rates to neutron dosimetry is discussed. An unfolded neutron spectrum is illustrated, along with energy sensitivity limits for many reactions of dosimetry interest.

12366 (LBL—10246) **Instructions for operating LBL Passive Environmental Radon Monitor (PERM).** Boegel, M.L.; Nazaroff, W.W.; Ingersoll, J.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1979. Contract W-7405-ENG-48. 17p. (EEB-Vent—79-14). Dep. NTIS, PC A02/MF A01.

The Passive Environmental Radon Monitor (PERM) is used to assess the impact of energy conservation in buildings, with reduced ventilation. Reduced ventilation can lead to increased concentration of air contaminants. The instrument operates on the principle of electrostatic collection of ^{218}Po ions. Cumulative alpha activity collects on the electrode and is detected with a lithium fluoride thermoluminescent detector. (FS)

12367 (UCRL—82657) **Development of a personnel neutron dosimeter/spectrometer.** Griffith, R.V.; Fisher, J.C.; Tommasino, L.; Zapparoli, G. (California Univ., Livermore (USA). Lawrence Livermore Lab.; Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1980. Contract W-7405-ENG-48. 6p. (CONF-800304—6). Dep. NTIS, PC A02/MF A01.

From 5. international congress of the International Radiation Protection Association; Jerusalem, Israel (8 Mar 1980).

A few inexpensive plastic track etch component, CR-39, polycarbonate, and LR-115 have been added to the albedo dosimeters. This will extend personnel neutron measurement capability, providing information to infer a four energy group spectrum, reduce the expected error in personnel dose assessment, and help clarify the ambiguity that results when personnel must work in more than one neutron facility during the monitoring period. (FS)

12368 Evaluation of gamma-ray response calculations for ^{7}LiF TLDs. Simons, G.G.; Emmons, L.L. (Argonne National Lab., Idaho Falls, ID (USA)). *Nucl. Instrum. Methods;* **160**: No. 1, 79-85(1 Mar 1979).

The accuracy of calculated gamma-ray dose ratios - the dosimeter dose relative to the surrounding medium dose - was investigated. Measurements were performed by exposing 1 X 1 X 6 mm ^{7}LiF thermoluminescent dosimeters encased in B_4C, teflon, Al, stainless steel, Cu, Ta, and Pb to ^{137}Cs, ^{54}Mn, and ^{60}Co gamma-ray sources. These data, in conjunction with the analytical expressions presented, were used to empirically select an appropriate electron spectrum attenuation coefficient. Calculations were in good agreement with the measurements for all dosimeter encasement materials and gamma-ray energies investigated.

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

REFER ALSO TO CITATION(S) 12179, 12219

12369 (UCRL—83095) **Pulsed calibration of the soft x-ray streak camera.** Kauffman, R.L.; Medecki, H.; Pierce, E.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nov 1979. Contract W-7405-ENG-48. 17p. (CONF-791135—6). Dep. NTIS, PC A02/MF A01.

From 21. annual meeting of the American Physical Society; Boston, MA, USA (12 Nov 1979).

In order to better understand laser plasma interactions an effort is being made to obtain quantitative temporally and spectrally resolved measurements in the low energy x-ray region using a soft x-ray streak camera. X-ray mirrors and absorption filters are employed to perform broad band spectroscopy measurements. The components of these systems have now been calibrated and the results of these measurements will be reported. The calibration of the x-ray streak camera, needed to make absolute flux measurements, cannot be measured using the usual x-ray sources because backgrounds interfere with the operation in the D.C. mode. Repetition rates and duty cycles are too low to complete calibration on a D.C. source in a reasonable time using the camera in a pulsed mode. As an alternative the calibrations are being done using a Nd(YAG) laser producing pulses of ~ 1 joule having pulse widths of ~ 150 ps. The x-ray flux is being monitored by three x-ray diodes having Al photocathodes. Absorption filters having the same thicknesses as those used with the streak camera provide x-ray energy responses of the diodes which approximate the channel responses of the streak camera. By comparing the charge from the diode with the integral response of the streak camera, the camera response can be measured. Preliminary results will be discussed.

12370 Time-domain spectroscopy of recoilless gamma rays. Baldwin, G.C. (Los Alamos Scientific Lab., NM (USA)). *Nucl. Instrum. Methods;* **159**: No. 2-3, 309-330(15 Feb 1979).

Alternatives to the conventional Doppler-scanning method of Moessbauer spectroscopy, which might offer improved resolution in spectroscopy of recoilless gamma rays, are considered. It is shown that the gamma ray frequency spectrum can be determined by observation of the time-distribution of delayed coincidence counts of photons transmitted by a stationary resonant filter. This may be the best alternative to Doppler scanning for long-lived transitions, especially if experiments to reduce the inhomogeneous linebreadth are to be undertaken. Some practical aspects of the design of systems for making this measurement are discussed, and experiments are suggested which would evaluate the method with known Moessbauer isotopes. In particular, it is suggested that one may be able to resolve the hyperfine splitting in natural iron and that one might observe dependences of the linebreadth upon the emission from an oriented iron-57 nucleus and on the hydrogen concentration in metallic tantalum. Long counting times and high background of chance coincidences are the principal limitations to the technique.

12371 Precise γ-ray energies for calibration of Ge semiconductor spectrometers to 3.5 MeV. Greenwood, R.C.; Helmer, R.G.; Gehrke, R.J. (Idaho National Engineering Lab., Idaho Falls (USA)). *Nucl. Instrum. Methods;* **159**: No. 2-3, 465-482(15 Feb 1979).

Precise measurements with Ge(Li) detectors of γ-ray energies from several radionuclides that are useful as calibration standards in Ge semiconductor spectroscopy have been extended up to 3.5 MeV. The technique generally employed has utilized cascade-crossover combinations, with the energies of the cascade γ-rays being measured relative to other close-lying γ-rays whose energies were already known and the energy of the crossover γ-rays being compared from the cascade sum. All the energies are referenced, in a traceable manner to the ^{198}Au γ-ray energy value of 411.80441 keV recently measured at the National Bureau of Standards. Radionuclides for which γ-ray energies are reported include: ^{24}Na, ^{48}V, ^{56}Co, ^{58}Co, ^{60}Co, ^{82}Br, ^{84}Rb, ^{88}Y, sup(110m)Ag, ^{124}Sb, ^{125}Sn, ^{133}Cs, ^{144}Ce, ^{207}Bi and ^{228}Th. Typical uncertainties in the measured energies range from 5 to 15 eV between 1.3 and 3.5 MeV.

12372 Helical focal plane detectors. Flynn, E.R. (Los Alamos Scientific Lab., NM (USA)). *Nucl. Instrum. Methods;* **162**: No. 1-3, 305-325(1979).

A general description is given of the theory, design and construction of helical delay line proportional counters for position determination along the focal plane of magnetic spectrometers. A discussion of the numerous designs now in use at various facilities is also presented together with their advantages and disadvantages. Spatial resolutions of 0.3-0.5 mm appear typical of this type of position sensitive detector. The energy loss information in the proportional region is also used for particle identification in many applications. The use of helical delay lines in hybrid heavy ion detectors is also disucssed.

12373 Hybrid focal plane detectors for heavy ions. Fulbright, H.W. (Rochester Univ., NY (USA). Nuclear Structure Research Lab.); Erskine, J.R. (Argonne National Lab., IL (USA)). *Nucl. Instrum. Methods;* **162**: No. 1-3, 355-370(1979).

Two non-identical twin gas-filled detectors for use at the focal plane of a magnetic spectrometer are described. They are single units containing an ionization chamber yielding a total energy signal, two position-sensitive proportional counters, and several electrodes giving ΔE/ΔX signals. The seven or eight pulses generated in this type of detector for each entering ion are encoded and sent to an on-line computer which can automatically find the nuclear charge, nuclear mass, ionic charge, energy, and angle of entry of each particle and can accumulate separate energy spectra for all specified ionic types of interest.

12374 Design of a pulsed neutron single crystal diffractometer for data collection in the Laue mode. Peterson, S.W.; Reis, A.H. Jr.; Willi, C.; Morgan, C.; Day, P. (Argonne National Lab., IL (USA)). *Acta Crystallogr., Sect. A;* **34**: No. , 338(1 Aug 1978).

From 11. international congress of the International Union of Crystallography; Warsaw, Poland (3 - 12 Aug 1978).

HIGH ENERGY PHYSICS INSTRUMENTATION

12375 (LBL—9366) **PEP-14 data acquisition system.** Madden, P.B.; Besset, D.; Freedman, S.J.; Harris, F.A.; Horne, C.P.; Losty, M.J.; Napolitano, J.; Vuillemin, V. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1979. Contract W-7405-ENG-48. 14p. (CONF-791215—6). Dep. NTIS, PC A02/MF A01.

From DECUS 1979 fall symposium; San Diego, CA, USA (10 Dec 1979).

A real-time software system was developed for the VAX 11/780 which employs ten processes cooperating concurrently in the task of data acquisition and on-line analysis for the Free Quark Search experiment at the new colliding beam storage ring facility (PEP) located at the Stanford Linear Accelerator Center. The system utilizes most of the resources available to the applications programer under VAX 11/780 VMS, including interprocess communication via mailbox, global event flag cluster, and mapped global section, and is written primarily in FORTRAN IV PLUS with time-critical portions in MACRO-11. A discussion of the system architecture, implementation, and performance is given. 6 figures, 1 table.

12376 Performance of a time-projection chamber. Fancher, D.; Hilke, H.J.; Loken, S.; Martin, P.; Marx, J.N.; Nygren, D.R.; Robrish, P.; Shapiro, G.; Urban, M.; Wenzel, W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Nucl. Instrum. Methods;* **161**: No. 3, 383-390(15 May 1979).

The design and operation of a position sensitive three-dimensional drift chamber with the capability of ionization sampling is reported. This detector allows simultaneous measurements of the momentum and the mass of charged particles. The device is a prototype for a large detector system to be built at the PEP storage ring facility.

12377 Magnet system for the time projection chamber at PEP. Green, M.A.; Eberhard, P.H.; Taylor, J.D.; Burns, W.A.; Garfinkel, B.; Gibson, G.H.; Miller, P.B.; Ross, R.R.; Smits, R.G.; Van Slyke, H.W. (Univ of Calif, Lawrence Livermore Lab). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 128-130(Jan 1979).

A superconducting solenoid with a conductive bore tube is under construction for use with the time projection chamber (TPC) detector at PEP. It will have a uniform induction of 1.5 T over a 6.3 m^3 volume. Its stored energy will be 11 MJ. A radiation thickness of 0.3 radiation lengths well be maintained for the coil package. The coil will operate at a current density of $7x10^8$ Am^{-2} and it will be cooled by force flow two phase helium in a tube. The final design details are given.

RADIOMETRIC INSTRUMENTS

12378 (PB—290735) **Instrument manual for prototype concrete consolidation monitoring device. Final report.** Lee, P.L.; Eggert, G.J. (Rexnord, Inc., Milwaukee, WI (USA)). May 1978. Contract DOT-FH-11-8588. 107p. NTIS, PC A06/MF A01.

This manual describes a Consolidation Monitoring Device (CMD) which has been designed to monitor consolidation of fresh concrete by measuring its density. Nuclear technology is used for sensing density by employing the Compton scattering phenomenon generally called nuclear backscatter. The source of nuclear energy for the instrument is Cesium 137 (137Cs) which emits gamma rays capable of penetrating several inches into the concrete. These rays, scattered about within the concrete, return in part to the sensing instrument which measures the rate of return and displays the count rate in terms of density or pounds per cubic feet (pcf). The CMD instrument is capable of measuring density on a continuous basis and has been adapted for measuring the density of a freshly laid concrete roadway while attached to the rear side of a slipform paver. The operation, calibration and maintenance procedures used in routine density measurements are described in detail in this manual. In addition, it provides information concerning the principles of density measurement, technical specifications of the various components, a functional description of the circuitry, and instructions on radiation safety. Illustrations and circuit schematics are contained in the body of the manual and a parts list is in the Appendix.

RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS

REFER ALSO TO CITATION(S) 12316, 12409

12379 (AD-A—065074) **Combined effect of aging and neutron irradiation on semiconductor avalanche voltage. Technical report.** Ruwe, V.W. (Army Missile Research and Development Command, Redstone Arsenal, AL (USA). Engineering Lab.). Apr 1978. 152p. NTIS PC A08/MF A01.

This report presents the results of an investigation into the combined effects of neutron irradiation and aging on the breakdown voltage in transistors. The combined effect was found to be a simple additive effect. It was determined from other results of the investigation that transistor parameters change as a function of the number of times the breakdown voltage is measured and that the gain of the transistor is degraded more if the device has been aged before irradiation than if the device has been irradiated and then aged. This last result brings into question the validity of present methods of establishing neutron susceptibility levels.

12380 (SAND—79-0211) **Evaluation of pullout cable EMR hardware design and potting methods.** Nelson, R.S.; Everett, R.R.S. (Sandia Labs., Albuquerque, NM (USA)). Jan 1980. Contract EY-76-C-04-0789. 30p. Dep. NTIS, PC A03/MF A01.

A continuing problem of undesirable voids in epoxy potting of pullout cable electromagnetic radiation (EMR) shields exists.

Three new EMR shields with smooth inner contours were developed to minimize void formation caused by air entrapment near sharp corners. Prototype cable assemblies were fabricated with the new shields. The prototypes were filled with both aluminum oxide (Al_2O_3) and beta eucryptite (Beta U) filled epoxies using single- and two-stage potting methods. Results demonstrate that the new shields are effective but that the major cause of voids is due to the shrinkage of epoxy during cure. The shrinkage problem (3 percent by volume) is overcome by careful two-stage potting into shields designed so that the volume for the second stage potting is extremely small.

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 11244, 11891, 11903, 12331, 12889

12381 (DOE/TIC—11042) **Computerized fuel measurement from x-ray radiography.** Green, D.R.; Karnesky, R.A.; Bromley, C. (Hanford Engineering Development Lab., Richland, WA (USA)). Nov 1979. Contract EY-76-C-14-2170. 11p. Dep. NTIS, PC A02/MF A01.

Techniques have recently been developed which allow nondestructive dimensional characterization of fuel pellets within fuel pins. Fuel pellet diameters can be measured with an accuracy of +- 0.0005 inch (0.0012 cm) using standard vendor-supplied radiography, or with an accuracy of +- 0.0002 inch (0.0005 cm) using x-ray radiography produced by a special HEDL developed technique. These data are needed for the detailed evaluation of the effects of irradiation on fuel behavior. The radiographs to be analyzed are transformed into a digital form using a computer controlled x-y scanning microdensitometer. The digital image is then recorded on a magnetic tape which is then sent to the central computer (CDC 6600) for analysis with FORTRAN IV software. Pellet diameters are determined, statistically analyzed, and the results are tabulated with a high speed line printer. These reports are also placed on magnetic tape storage for future computerized comparison and evaluation.

12382 (EPRI-NP—1212) **Measurement of the thickness of liquid film by means of capacitance method. Interim report.** Leskovar, B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 68p. Dep. NTIS, PC A04/MF A01.

A technique was developed for measuring water film thickness in a two phase annular flow system by means of the capacitance method. Theoretical considerations are applied to estimate the capacitance value as a function of the film thickness. An experimental model of the flow system with two types of electrodes mounted on the inner wall of a cylindrical tube was constructed and evaluated. The ability of the apparatus to observe fluctuations and wave motions of the water film passing over the electrodes is described.

12383 (LBL—7293) **Microwave spectrometer for the detection of transient gaseous species.** Kolbe, W.F.; Zoellner, W.D.; Leskovar, B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1979. Contract W-7405-ENG-48. 30p. Dep. NTIS, PC A03/MF A01.

A microwave spectrometer and associated apparatus for the detectin of unstable free radical species is described. The spectrometer, which operates over a frequency range from 66 to 73 GHz, consists of a tunable Fabry-Perot resonator followed by superhetrodyne detection for high sensitivity at low power levels. The resonator tuning is accomplished by means of a computer controlled stepping motor and by a piezoelectric transducer which also permits the use of source modulation and phase sensitive detection at 100 Hz. The sensitivity of the spectrometer is adequate to permit the detection of rotational transitions with absorption coefficients as small as 2 x 10^{-9} cm^{-1}. The operation of the spectrometer is demonstrated by the detection of the two free radical species OH and SO. In the case of OH, a number of Λ-doubling transitions, previously unobserved, are reported.

12384 (NTIS/PS—79/0478) **Atmospheric particle detectors (A bibliography with abstracts). Report for 1964-April 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). May 1979. 221p. NTIS PCN01/MF N01.

The cited reports cover detectors that are used primarily in air pollution and mine emission applications. Citations include monitoring site selection, applicable instrumentation, and determination of particle concentration. Excluded are studies on the chemical analysis of particles. (This updated bibliography contains 213 abstracts, 28 of which are new entries to the previous edition.)

12385 (PB—293769) **Calibration and performance evaluation of a single-wavelength transmissometer for monitoring particulate mass concentration of emissions from stationary sources. Final report.** Uthe, E.E. (SRI International, Menlo Park, CA (USA)). Jul 1978. Contract EPA-68-01-4137. 38p. NTIS, PC A03/MF A01.

This experimental study investigated the validity of using a single-wavelength infrared transmissometer to measure mass concentration of particulate emissions from stationary sources. Previous data and theory have indicated that an optimum wavelength region (3 to 4 micrometers) exists for relating aerosol extinction to mass concentration, independent of size of the scattering particles. Results show that the extinction-to-mass concentration ratio for a given aerosol type is dependent on particle size at the visible wavelength but nearly independent of particle size at the infrared wavelength. Therefore, the infrared transmissometer is an eminently suitable instrument for monitoring mass concentration of particulate emissions with uncontrolled particle sizes. Moreover, the results obtained for the different particle types indicate that this transmissometer can provide estimates of particulate volume concentration that are nearly independent of particle shape, composition, or size.

12386 (SAND—78-2069) **Evaluation of hand-held ion-mobility explosives vapor detectors.** Burrows, T.A.; Thoma, P.J. (Sandia Labs., Albuquerque, NM (USA)). Dec 1979. Contract EY-76-C-04-0789. 17p. Dep. NTIS, PC A02/MF A01.

Two types of ion-mobility detectors were evaluated in both laboratory and field tests. Laboratory test results show that these detectors are highly sensitive to dynamite and pistol powder and have good false-alarm agent rejection. Field tests of these two detectors revealed that they would detect dynamite and Ball-C-Propellent in free air. However, neither of the ion-mobility detectors would detect these explosives if the explosives were concealed.

12387 (SAND—79-1230) **Characterization of digital filters used in Sandia Laboratories Test Data Analysis Division.** Walter, P.L.; Rodeman, R. (Sandia Labs., Albuquerque, NM (USA)). Dec 1979. Contract EY-76-C-04-0789. 56p. Dep. NTIS, PC A04/MF A01.

This report characterizes the digital filters used by the Test Data Analysis Division at Sandia Laboratories. Problems associated with designing filters to minimize errors introduced by the filters are discussed.

12388 (SAND—79-1380) **Study of high-altitude radar altimeter model accuracy and SITAN performance using HAAFT data.** Shieves, T.C.; Callahan, M.W. (Sandia Labs., Albuquerque, NM (USA)). Jul 1979. Contract EY-76-C-04-0789. 161p. Dep. NTIS, PC A08/MF A01.

Radar altimetry data, inertial navigation data, and scoring data were collected under the HAAFT program by Martin Marietta Corporation for the United States Air Force over several areas in the western United States at altitudes ranging from 3 to 20 km. The study reported here uses the HAAFT data in conjunction with Defense Mapping Agency (DMA) topographic data to evaluate the accuracy of a high-altitude pulsed-radar altimeter model and the resulting performance of the terrain-aided guidance concept SITAN. Previous SITAN flight tests at low altitudes (less than 1500 m AGL) have demonstrated 6-20 m CEP. The high-altitude flight test data analyzed herein show a SITAN CEP of 120 m. The radar altimeter model was required to achieve this performance includes the effects of the internal track loop, AGC loop, antenna beamwidth, and the terrain radar cross section and provided a factor of 6 improvement over simple nadir ground clearance for rough terrain. It is postulated that high-altitude CEP could be reduced to 50 m or less if an altimeter were designed specifically for high-altitude terrain sensing.

12389 (SAND—79-1633) **Applications of the coherence function in comparing seismometers.** Stearns, S.D. (Sandia Labs., Albuquerque, NM (USA)). Dec 1979. Contract EY-76-C-04-0789. 33p. Dep. NTIS, PC A03/MF A01.

A study is reported on the coherence function and its applicability in comparing two seismometers. Such comparisons are made to determine how much of the seismometer outputs consist of true earth motion as opposed to internal noise. The purposes of this report are: (1) to provide a descriptive discussion of the coherence function and related functions; (2) to show that the standard method of computing coherence can give misleading results; (3) to present the results of a study of methods for unbiasing the coherence estimate; and (4) to present a preferred scheme for computing coherence. Two examples using real data are included.

12390 (SAND—79-1714C) **Development of a laser interferometric dilatometer.** Drotning, W.D. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 32p. (CONF-791134—6). Dep. NTIS, PC A03/MF A01.

From 16. international thermal conductivity conference; Chicago, IL, USA (7 Nov 1979).

The development of a high precision dilatometer using laser interferometry is described. Design criteria require operation over a temperature range from ambient to 900°K with a length change sensitivity of ten microinches (0.25 μm) or less. The dilatometer is designed to achieve rapid sample turnaround for quality control measurements in a production environment. To achieve this, design features are incorporated which minimize sample preparation time by relaxing critical size and shape restrictions on test samples. The

length change measurement is based on a modified Michelson interferometer using a two-frequency HeNe laser and ac detection of fringes. The final critical alignment of the interferometer during sample installation is achieved by automatic computer control. This alignment control feature can be used to maximize interferometer alignment continuously through the course of a run. The furnace system incorporates a low thermal mass heating chamber to achieve rapid thermal response with minimal thermal disturbance to the interferometer system. Flexibility and reproducibility in heating schedules are achieved through digital control. Dilatometer control and data acquisition functions are accomplished by a minicomputer using a standard interface bus.

12391 (UCID—18493) **Computer controlled calibration system: CBU. Users guide.** Ables, E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Dec 1979. Contract W-7405-ENG-48. 27p. Dep. NTIS, PC A03/MF A01.

The calibration system is a collection of special-purpose CAMAC modules that provide programmable calibration signals for the purpose of calibrating data acquisition systems used to collect data from various types of transducers. The processor-based controller receives high-level English-type commands over a IEEE-488 bus, interprets the commands, then translates them into command signals to the calibration modules. CAMAC's modular structure provides easy configuration of a calibration system to match the data acquisition system. 11 figures.

12392 (UCID—18520) **Streakcamera aperture function.** Dunbar, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Dec 1979. Contract W-7405-ENG-48. 14p. Dep. NTIS, PC A02/MF A01.

The aperture function of a streaktube is derived. It defines the input spectrum as a function of time and space. It is found that the zeros of the aperture function depend inversely on aperture size and sweep time.

12393 **Microcomputer automation of the sample probe of an ESCA spectrometer.** Fischer, J.W.; Downey, R.M.; Schrawyer, L.R.; Meisenheimer, R.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *J. Electron Spectrosc. Relat. Phenom.;* **16**: No. 6, 475-480(Jun 1979).

Many of the currently available ESCA spectrometers can be obtained with fully automated control and data acquisition systems as well as a variety of algorithms for data processing. The majority of these computer-controlled functions, however, are directed toward the analysis of a single physical sample. Since many analyses require the collection of data for several hours for the purpose of ensemble averaging to enhance the signal-to-noise ratio, overnight operation is a common practice. It is during these periods that a capability for multiple sample analyses would be most useful. The subject instrument for the automation was a Hewlett-Packard Model 5950A ESCA spectrometer which was supplied with a Hewlett-Packard 5952A Data System consisting of a Hewlett-Packard 2100A small computer and a Hewlett-Packard 85001A Magnetic Tape Cassett I/O unit. A microprocessor based system was used to implement this automation. The system uses the high-level language BASIC for virtually all control functions, thus providing the obvious advantages of rapid programming and ease of software modification over an assembly language although more ROM is required.

12394 **Efficient two-dimensional scanner for beta emitters.** Markham, R.G.; Austin, S.M.; Stya, M. (Michigan State Univ., East Lansing (USA). Cyclotron Lab.). *Nucl. Instrum. Methods;* **160**: No. 1, 49-53(1 Mar 1979).

A line scanner has been developed which permits the localization and real time quantification of β emitters on a flat two-dimensional surface. With a well maintained detector the spatial resolution is 2-3 mm (full width half-maximum) in each dimension with an overall detection efficiency (for a 20 cmx5 cm area) of about 0.5%. The β particle is detected in a pair of linear position sensitive proportional counters, one located behind the other, and the origin of the decay β is obtained by ray tracing in one dimension and scanning in the other. By this technique a large solid angle can be accepted without substantial degradation of position resolution. The device can also be used as a one-dimensional detector with an overall efficiency of about 10%. Applications have been made to the detection of β's from the decay of ^{13}N and ^{14}C.

12395 **Transresistance instrumentation amplifier.** Agouridis, D.C.; Fox, R.J. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Proc. IEEE ;* **66**: No. 10, 1286-1287(Oct 1978).

A transresistance instrumentation amplifier (dual-input transresistance amplifier) was designed, and a prototype was fabricated and tested in a gamma-ray dosimeter. The circuit, explained in this letter, is a differential amplifier which is suitable for amplification of signals from current-source transducers. In the dosimeter application, the amplifier proved superior to a regular (single) transresistance amplifier, giving better temperature stability and better common-mode rejection.

WELL LOGGING INSTRUMENTATION

REFER ALSO TO CITATION(S) 11252, 11738, 11739, 11740, 11741

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

12396 (AD-A—065914) **Free-flight measurement of the drag forces on cylinders in Event Dice Throw. Technical paper.** Gibb, A.W.M.; Hill, D.A. (Defence Research Establishment Suffield, Ralston, Alberta (Canada)). Feb 1979. 156p. NTIS, PC A08/MF A01.

Previous determinations of drag coefficients for both steady and unsteady flow are reviewed for all reported experiments at critical and supercritical Reynolds numbers. The unsolved problems remaining from earlier DRES work were found to be: end effects, dust drag loading, the discrepancies between steady and unsteady flow drag forces, and the need for a further data analysis. A new analysis is also presented for the drag coefficient as a function of flow Mach number and cylinder length-diameter ratio. A plan of test is presented for drag force measurements on cylinders during Event DICE THROW, a 628-ton AN/FO explosion held in October 1976. The objectives of this experiment were to provide drag force support data for the lattice mast and all antennas in Event DICE THROW, and to extend the table of data for drag coefficients to diameters up to 18 inches. The free-flight measurement technique, using both cameras and velocity transducers for data sources, was employed on seven cylinders at 20, 10 and 7 psi overpressure levels. The expected motion of each cylinder was calculated, based on the predicted value for the drag coefficient. Finally, suggestions for the data analysis and for further research in this area are discussed.

12397 (LA—7989) **Numerical modeling of sympathetic detonation.** Bowman, A.L.; Kershner, J.D.; Mader, C.L. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 22p. Dep. NTIS, PC A02/MF A01.

The sympathetic detonation of small cubes of solid rocket propellant was modeled numerically, using the Eulerian reactive hydrodynamic code 2DE with Forest Fire burn rates. The model was applied to cubes of 1 to 3 in., with excellent agreement between calculated and experimental results. The model also was applied to several propellants and to different experimental arrangements. The blast-wave pressures in the air gap and the induced shock pressures in the acceptor were obtained from the model. The correlation between these pressures was coupled with a study of the effect of the length-to-diameter ratio of a donor cylinder and the necessary conditions for detonation of the acceptor to provide a semiquantitative predictive capability.

12398 (LA—8124-MS) **Explosives research and development: recommendations and comments on unsolved problems.** Smith, L.C. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 46p. Dep. NTIS, PC A03/MF A01.

Historical highlights and the current status of the science of high explosives are briefly reviewed, and recommendations and comments on areas deserving special attention during the next decade or so are offered.

12399 (MHSMP—80-03) **Recrystallization of TATB for analytical standard.** Schaffer, C.L. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Jan 1980. Contract EY-76-C-04-0487. 8p. Dep. NTIS, PC A02/MF A01.

A 780 g analytical standard of TATB was prepared by recrystallization from reagent grade dimethylformamide. The resulting recrystallized product appears to be the purest TATB produced to date, in larger than gram quantities. The average assay of seven samples was 99.98% with a standard deviation of 0.29%.

12400 (UCID—18297) **Preparation of candidate energetic materials for munition acceleration.** Hornig, H.C.; Moody, G.L.; Boat, R.M.; Fordyce, K.V. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Oct 1979. Contract W-7405-ENG-48. 8p. Dep. NTIS, PC A02/MF A01.

A small task was undertaken to supply candidate propellants or explosives to the Tomahawk program covering a wide range of explosiveness. Small discs of material were needed for a screening test to determine the ability of the propellant or explosive to accelerate a munition to about 60 m/s (200 ft/s) with an explosive-like reaction without damaging the munition. The scheme was an alternative to more conventional solid propellant motors. A preliminary trial with C-4 explosive was very promising but caused some damage to the munition. The strategy in this task was to select energetic composite explosives and propellants which varied in their tendency

to detonate and could be expected to react in a vigorous deflagration or weak detonation.

12401 (MLM—2662(TR)) **Relationship between electron structure and the sensitivity of secondary nitro explosives: molecular criteria of sensitivity. Part 1. Nitroaromatics and nitramines.** Delpuech, A.; Cherville, J. Translated from *Propellants Explos.;* **3**: 169-175(1978). 19p. Dep. NTIS, PC A02/MF A01.

The paper is the first of a series in which an attempt is made to establish a relation between shock sensitiveness of secondary explosives and their electronic structure. In the case of nitroaromatics and nitramines, the preferential action of a $R\text{-}NO_2$ bond of the molecule is made evident in the course of the initiation of the detonation. The examination of the modifications undergone by the electronic distribution of this bond after the absorption of energy enables to determine a parameter perfectly correlated with the scale of experimental sensitivities. The validity of this parameter as a criterion of sensitiveness demonstrates the existence of an excited state before detonation.

NUCLEAR

12402 (AD-A—066103) **Ground shock interactions with nuclear-explosion produced chimneys. Topical report, 15 November 1976-15 November 1977.** Patch, D.F.; Kent, G.I.; Welch, J.E. (Pacifica Technology, Del Mar, CA (USA)). 20 May 1978. Contract DNA001-78-C-0066. 96p. NTIS, PC A05/MF A01.

Results from a series of two-dimensional ground motion calculations are reported. The calculations represent a first cut at understanding both the dynamic and late-time interactions between an underground nuclear test and an existing nuclear explosion-produced chimney. Two general configurations were examined: detonations adjacent to a nearby chimney and detonations at the working point of a prior explosion which has produced a chimney. In the adjacent chimney study, two chimney separation distances were investigated for two bounding cases of chimney material strength. The effects of different material strength and chimney shape were studied in the in-chimney computations. Taken together, the computations show the importance of accurately knowing the material response of the chimney material. Material response models used in the computations and the data on which they are based are discussed in detail. All computations for the nearby chimney predict a competent late-time residual hoop stress about the new cavity for the range of properties and separation distances considered. Decreasing the chimney material strength, and to a lesser extent, reducing the separation distance enhanced the influence of the chimney on the magnitude of the dynamic stress field in the region around the new shot point. Reducing the competence of the chimney material in the in-chimney computations dramatically altered both the ground motion and the residual stress field. This sensitivity of the results to the chimney properties suggests that extensive material properties data will be required if a new test is to be conducted, either very near or inside the chimney of an old event.

12403 (AD-A—069521) **High risk areas of the United States identified by congressional district. Technical report.** Sager, E.V.; Hulburt, C.W.; Sullivan, R.J. (System Planning Corp., Arlington, VA (USA)). May 1979. Contract DCPA01-79-C-0192. 42p. NTIS, PC A03/MF A01.

This report locates by congressional district within each state of CONUS those areas subject to blast damage in a counterforce attack as identified in TR-82. These areas are identified by cross-hatch on state maps.

WEAPONRY

12404 (AD-A—068462) **High explosive multiburst airblast phenomena (simultaneous and non-simultaneous detonations). Final report.** Reisler, R.E.; Kennedy, L.W.; Keefer, J.H. (General Electric Co., Albuquerque, NM (USA). TEMPO). Feb 1979. Contract DNA001-77-C-0305. 132p. NTIS, PC A07/MF A01.

This document is the final summary report on a series of sixteen high explosive multiburst detonations which were carried out as part of Project DIPOLE WEST. The series was conducted during the summers of 1973, 1974, and 1975 at the Defence Research Establishment, Suffield, Alberta, Canada, and was sponsored by the Defense Nuclear Agency. The sixteen events were divided into three phases. In the first phase, two charges at the same elevation but separated horizontally were detonated simultaneously. In the second phase, the charges were placed one above the other, but still detonated simultaneously. Finally, in the third phase, vertically separated, non-simultaneous detonations were investigated. The report summarizes the information obtained from electronic pressure transducers and from high-speed photography. The latter was subjected to extensive photogrammetric analysis. Significant insight into the redistribution of energy in blast waves as they pass over real and ideal surfaces was gained, and information was obtained about the interaction of Mach stem shocks under various conditions. General validation of hydrodynamic calculational techniques, plus the development of code modifications appropriate for multiburst situations, was a major accomplishment from this analysis.

12405 (AD-A—068490) **Damage assessments of blast risk areas in missouri. Technical report.** Sager, E.V.; Marshall, M.O.; Hulburt, C.W.; Sullivan, R.J. (System Planning Corp., Arlington, VA (USA)). Apr 1979. Contract DCPA01-79-C-0192. 40p. NTIS, PC A03/MF A01.

This report provides more detailed data on a county-by-county basis of the effects of a counterforce attack on the ICBM complex in Missouri. Data are given for casualties and effects on housing, emergency operating centers, hospitals, radio and TV, and food processing.

12406 (AD-A—068494) **Source development for an array to generate underwater rectangular pulses. Final report 1 oct 77-30 apr 78.** Florence, A.L.; Romander, C.M. (SRI International, Menlo Park, CA (USA)). 30 Apr 1978. Contract DNA001-77-C-0210. 43p. NTIS, PC A03/MF A01.

SRI International is assisting the Defense Nuclear Agency (DNA) and the Underwater Explosion Research Division (UERD) in developing a technique for generating a plane wave in water to simulate the pulse generated by an underwater nuclear explosion. The technique is being developed to improve the current method of loading submarine sections in which the energy source is concentrated as a large sphere or as a single line of explosive. The technique design consists of a vertical square array of equally spaced point sources. Each source is a compact coil of Primacord explosive wound on a simple cylindrical mandrel; the coil axes are horizontal and perpendicular to the array plane. Simple exploratory tests at SRI with single small-scale coils of mild detonating fuze and a full-scale test at UERD with a Primacord coil produced pulses that superposed to predict a satisfactory array pulse, apart from an excessive rise time. An approximate analysis was performed that provided a simple formula for the array pulse resulting from specified point source pulses. The principal result is that the array pulse rise time is about the same as the characteristic time of the source pulse. This result suggested that the array pulse rise time will be decreased if the linear density of the explosive strand forming the coil is decreased substantially over the final two-thirds of its length.

12407 (UCID—18494(Pt.2)) **Conflict Simulation Laboratory-II. Part 2. Design comcept.** Ames, H.S.; Bly, S.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Dec 1979. Contract W-7405-ENG-48. 47p. Dep. NTIS, PC A03/MF A01.

The Conflict Simulation Laboratory (CSL) is a part of D-Division and provides graphic and computation tools to model nuclear combat through simulated tactical battlefields and war games. In order to alleviate some of the limitations and problems of the Conflict Simulation Laboratory it is proposed that the current facilities be enhanced. A recommended design is presented. The design is a first-level design with sufficient detail to enable the generation of development schedules, the prediction of costs and the formulation of hardware specifications. The actual hardware and software purchased will depend on the funds available.

12408 (UCRL—50016-80-1) **Mechanical Engineering Department. Technical review.** Simecka, W.B.; Condouris, R.A.; Talaber, C. (eds.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Jan 1980. Contract W-7405-ENG-48. 64p. Dep. NTIS, PC A04/MF A01.

The Mechanical Engineering Department Technical Review is published to (1) inform the readers of various technical activities within the Department, (2) promote exchange of ideas, and (3) give credit to the personnel who are achieving the results. The report is formatted into two parts: technical achievements and publication abstracts. The first is divided into eight sections, one for each Division in the Department providing the reader with the names of the personnel and the Division accomplishing the work.

12409 (UCRL—52804) **Probabilistic approach to EMP assessment.** Bevensee, R.M.; Cabayan, H.S.; Deadrick, F.J.; Martin, L.C.; Mensing, R.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1979. Contract W-7405-ENG-48. 50p. Dep. NTIS, PC A03/MF A01.

The development of nuclear EMP hardness requirements must account for uncertainties in the environment, in interaction and coupling, and in the susceptibility of subsystems and components. Typical uncertainties of the last two kinds are briefly summarized, and an assessment methodology is outlined, based on a probabilistic approach that encompasses the basic concepts of reliability. It is suggested that statements of survivability be made compatible with system reliability. Validation of the approach taken for simple antenna/circuit systems is performed with experiments and calculations that involve a Transient Electromagnetic Range, numerical antenna modeling, separate device failure data, and a failure analysis computer program.

EXPLOSION DETECTION

12410 (AD-A—065772) **Special data collection system (SDCS) Tuamotu Archipelago Region, 19 February 1977. Technical report.** Dawkins, M.S. (Teledyne Geotech, Alexandria, VA (USA)). May 1978. Contract F08606-78-C-0007,. 12p. NTIS, PC A02/MF A01.

This event report contains seismic data from the Special Data Collection System (SDCS), and other sources for the Tuamotu Archipelago Region event.

12411 (AD-A—065773) **Special data collection system (SDCS), Eastern Kazakh, SSR, 25 April 1977. Technical report.** Dawkins, M.S. (Teledyne Geotech, Alexandria, VA (USA)). 27 Apr 1978. Contract F08606-78-C-0007. 10p. NTIS, PC A02/MF A01.

This event report contains seismic data from the Special Data Collection System (SDCS), and other sources for the Eastern Kazakh, SSR event.

12412 (AD-A—069802) **Summary of seismic discrimination and explosion yield determination research. Final report.** Bache, T.C.; Savino, J.M.; Day, S.M.; Cherry, J.T.; Swanger, H.J. (Systems, Science and Software, La Jolla, CA (USA)). Nov 1978. Contract F08606-76-C-0041,. 138p. NTIS, PC A07/MF A01.

This report summarizes the work accomplished in a twenty-four month research program directed toward resolution of technical issues arising in the seismic verification of an underground nuclear test ban treaty. Emphasis is on research conducted during the last year in five subject areas: data analysis, source studies, grout experiments, surface wave studies and body wave studies. Results are summarized for thirteen research projects. The report also includes an appendix in which abstracts are listed for seventeen technical reports submitted under this contract. Also included are the abstracts for twelve reports submitted under a preceding fifteen month contract.

12413 (AD-A—069864) **Effect of burial depth on seismic signals. Volume II. Final report 1976-1978.** Perl, N.; Thomas, F.J.; Trulio, J.; Woodie, W.L. (Pacific Sierra Research Corp., Santa Monica, CA (USA)). May 1979. Contract DNA001-76-C-0078. 203p. NTIS.

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 11283, 12249, 12421

12414 (BNL—26892) **Atmospheric stability comparisons at shore and inland sites.** Brown, R.M.; SethuRaman, S.; Nagle, C. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 3p. (CONF-800107—1). Dep. NTIS, PC A02/MF A01.

From 2. conference on coastal meteorology; Los Angeles, CA, USA (30 Jan 1980).

The values needed to predict diffusion and resulting concentrations from sources near coastlines is limited by lack of experimental data at coastal locations. The results obtained in this study are directed to assist in those calculations. Wind measurements made at the coastal site and some comparisons with the measurements made at an inland location, both on Long Island, are presented. Continuous wind speed and direction measurements have been made at the Tiana Beach site since 1975. Hourly averaged wind direction, speed and gustiness types were obtained from these records, and processed by computer techniques. Simultaneous data from the inland location were also obtained. The data were grouped with a digital computer according to gustiness types, wind-speed categories and 10^0 wind direction increments from 0 to 360 degrees. The initial analysis was to separate the various gustiness types by the number of occurrences per month at each location. These data were used to determine the ratio of each type to the total monthly hours at each place. The ratios at each location were compared to give some understanding of the differences of total gustiness between the coastal and inland site.

12415 (BNL—50977) **Environmental programs of the Department of Energy and Environment annual highlights.** Manowitz, B. (Brookhaven National Lab., Upton, NY (USA)). Dec 1978. Contract EY-76-C-02-0016. 109p. Dep. NTIS, PC A06/MF A01.

Environmental Sciences is one of the four areas comprising the Department of Energy and Environment at Brookhaven National Laboratory. It carries out a wide range of activities in atmospheric sciences, environmental chemistry, oceanographic sciences, and land and freshwater environmental sciences. In general, these programs are concerned with identification and measurement of pollutants introduced into the environment by energy-related activities and the evaluation and prediction of the effects or potential effects of these pollutants on the environment. This highlights report for Environmental Programs covers the year 1978 and describes the objectives and funding levels of each of the programs, major accomplishments during the year, planned future activities, and current publications.

12416 (CONF-790902—, pp 47-52) **Vectorized three-dimensional operational tropical cyclone model.** Madala, R.V. (Naval Research Lab., Washington, DC); Chang, S. 1979.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

A three-dimensional numerical model to predict the intensification and movement of tropical cyclones is under development at the Naval Research Laboratory using TI-ASC computer. The physics of the model includes latent heat released in convective and non-convective clouds. The atmospheric boundary layer is parameterized using generalized similarity theory. A newly developed fully vectorisable time integration scheme, split-explicit, is used to integrate the governing equations. In this scheme all the dependent variables are initially expanded in terms of the natural eigen modes of the model. The spectral equations governing the eigen modes are integrated using a time step which varies with each mode. These modes are then recombined at regular intervals of time to obtain the required solution. Use of this method has enabled us to reduce the computing time requirements by a factor of four compared to the conventional explicit schemes. For a horizontally staggered 51 x 51 x 7 grid network with a horizontal resolution of 60 km, each computational cycle of the model requires 3.85 seconds when run in vector mode and 15.25 seconds when run in scalar mode.

12417 (CONF-790902—, pp 54-59) **Use of the Cray-1 simulating hail growth.** Berkowitz, C.M. (Battelle, Pacific Northwest Lab., Richland, WA). 1979.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

A two-dimensional (x,z) Monte Carlo model of the hail growth zone was used to investigate the effects of updraft tilt and width on hail production. To allow for selection processes necessary to resolve the difference between the concentration of hailstone embryos and the concentration of hailstones, the growth of a large number of embryos had to be simulated. Development of this model on a CDC-7600 computer required extensive tape and mass storage buffer operations to model the many growing particles. By modifying the program to run on the newly avalable Cray-1 computer, most of the I/O operations were no longer necessary, and computation times were greatly reduced. This allowed for a more extensive investigation than would otherwise have been possible.

12418 (CONF-791065—2) **Use of oxygen isotopy in the study of SO_2 to sulfates in the atmosphere.** Holt, B.D.; Cunningham, P.T.; Kumar, R. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 8p. Dep. NTIS, PC A02/MF A01.

From WMO symposium on the long-range transport of pollutants and its relation to general circulation including stratospheric/tropospheric exchange processes; Sofia, Bulgaria (1 Oct 1979).

Previous experimental results have indicated that the $^{18}O/^{16}O$ ratios in water vapor, precipitation water, and sulfate contained in precipitation water vary seasonally (higher in summer, lower in winter), while the $^{18}0/^{16}0$ ratio in atmospheric particulate sulfate appears to vary randomly with season. The samples were arbitrarily intermittent and therefore did not necessarily represent continuous, temporal variations of the oxygen isotopes, except during the three-day sampling period within each month. It was postulated on the basis of the data obtained, that since the two-year averages of $^{18}0$ content in particulate sulfate and precipitation sulfate were about equal, both were probably formed by the same aqueous oxidation mechanism in clouds. In recent studies, sequential seven-day samples of water vapor, particulate sulfate and sulfur dioxide were continuously collected throughout the four seasons. Samples of rain and snow were also collected for most of the precipitation events during this period. The results obtained from this more intensive sampling program give an alternative and possibly more accurate interpretation of the apparent lack of agreement between the isotopic qualities of precipitation and particulate sulfates. Results indicate that SO_2 in the atmosphere is converted to sulfate in the late fall, winter, and early spring predominantly by an aqueous oxidation mechanism that yields sulfates isotopically similar, if not identical, to sulfates found in precipitation water: while in the late spring, summer, and early fall, SO_2 is converted predominantly by a sun-induced mechanism that yields sulfates more depleted in $^{18}0$. The predominating summer mechanism(s) may involve reactions of SO_2 with 0H radicals or other free radicals, or reactions with photochemically produced aqueous-phase oxidants, such as H_20_2. (JGB)

12419 (DOE/ET/10040—1) **Role of temperate zone forests in the world carbon cycle: problem definition and research needs.** Armentano, T.V.; Hett, J. (eds.). (Institute of Ecology, Indianapolis, IN (USA)). Aug 1979. Contract AC02-79EV10040. 69p. Dep. NTIS, PC A04/MF A01.

The proceedings of a workshop on carbon uptake and losses from temperate zone forests are reported. Total standing stock and growth recovery transients were examined for most of the temperate region over a period from pre-settlement times to the present, with emphasis on the last three decades. Because of data availability, certain regions and topics were covered more in detail than others. The forest inventory data reviewed here suggests the temperate zone forests could have functioned for the past several decades as a net sink for 10^9 tons of carbon annually. This is nearly one-half of the total annual rise in carbon concentration of the atmosphere. However, due to the limited data on non-commercial timberlands, nonmerchantable tree components, and soil organic matter changes, the precision of this estimate of temperate zone C retention may be only within one-quarter to one-half of the true value. Despite this limitation, the available data suggests strongly that temperate zone forests probably are not a source of carbon as implied by the 2.2 x 10^9 tons annual release postulated by Woodwell et al (1978). The principal areas for which new information would reduce uncertainties in estimates of carbon uptake and losses from temperate zone forests are discussed, and recommendations are made for a series of research initiatives to increase resolution of the problem areas. (JGB)

12420 (EDFB/IBP—78/2) **SEDFAL: a model of dispersal of tree seeds by wind.** Fields, D.E.; Sharpe, D.M. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 110p. Dep. NTIS, PC A06/MF A01.

SEDFAL, a numerical model of windblown seed dispersal, simulates seed release as a function of humidity and wind speed for each month of the dispersal interval. Seed terminal velocities are parameterized as a 10-bar histogram, and winds are described according to their frequency of occurrence in 10 wind-speed, 16 direction, and 5 vapor pressure deficit classes. The simulated seed dispersal pattern is summarized numerically, and may be displayed in printer plot form or plotted on a graphics device, with or without numerical smoothing, at the user's discretion.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 11123, 11130, 11997, 12482, 12651, 12652, 12666, 12669, 12670, 12671

12421 (AD-A—065026) **Meeting of the High Altitude Pollution Program Scientific Advisory Committee. (1st). Executive summary.** (Federal Aviation Administration, Washington, DC (USA). Office of Environment and Energy). Dec 1978. 23p. NTIS PC A02/MF A01.

This is the Executive Summary of the first meeting of the High Altitude Pollution Program Scientific Advisory Committee which met in Washington, D.C. from November 29-December 1, 1978. The Committee is composed of 25 members who are experts in a number of fields related to atmospheric chemistry and physics, aviation, and engineering.

12422 (BMFT-FB-T—79-114) **Systematic report on the formation and the control of annoying odor emissions. Final report.** Maurer, P.G.; Brunner, H.; Schindler, S.; Kastka, J.; Kremer, H.; Quillmann, H.; Wirth, K.H. (Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.)). Dec 1979. 428p. (In German). Dep. NTIS (US Sales Only), PC A19/MF A01.

The problems connected to the appearances of annoying odor emissions are demonstrated. The following subjects were studied: classification and evaluation of the air pollution by odorous compounds; toxic effects of the odorous compounds; sources of odor emissions; diffusion of odorous compounds in the environment of emission sources; odorous compounds analytical methods; and, odor emissions control methods.

12423 (CONF-781108—, pp 146-168) **Improving the reliability of econometric models.** Welsch, R.E. (Massachusetts Inst. of Tech., Cambridge). Jul 1979.

From 4. DOE statistical symposium; Albuquerque, NM, USA (1 Nov 1978).

This paper describes new techniques that can help to improve the reliability of econometric and other models. Diagnostic methods are employed to discover influential observations - those which may have undue importance in determining predictions, coefficient estimates, etc. Techniques based on the deletion of a single observation are the most developed and will be briefly summarized. Recent results on the deletion or perturbation of subsets of observations will be described in connection with the use of leverage plots. A new fitting procedure called bounded influence estimation is also discussed. These methods will be applied to a model with thirteen explanatory variables which tries to relate housing prices to levels of pollution in 506 Boston Metropolitan Area census tracts.

12424 (LA—7979-PR) **Development of a sampling and analytical method for styrene oxide, November 1, 1978-March 31, 1979.** Stampfer, J.F.; Hermes, R.E.; Weeks, R.W. Jr.; Campbell, E.E.; Ettinger, H.J. (Los Alamos Scientific Lab., NM (USA)). Dec 1979. Contract W-7405-ENG-36. 16p. Dep. NTIS, PC A02/MF A01.

A method is described for the collection and analysis of airborne styrne oxide. The sampler consists of a tube holding a glass fiber filter followed by a sorbent, Tenax-GC. The styrene oxide is extracted from the sampler with ethyl acetate and an aliquot analyzed by gas-liquid chromatography. Recoveries of > 95% were obtained with samples (0.5 to 44 μg) collected from 80% relative humidity test atmospheres. The coefficient of variation for the method, including an assumed pump error of +- 5%, was 0.076. The limit of detection of the analytical method was 0.1 μg per sample. Stability and interference studies indicate the method to be suitable for personal monitoring.

12425 (LBL—10125) **Determination of low-z elements in atmospheric aerosols by charged-particle-induced nuclear reactions.** Clemenson, M.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 130p. Dep. NTIS, PC A07/MF A01.

Thesis.

Nuclear reactions induced by charged particles are used to determine total carbon, nitrogen, and oxygen in atmospheric aerosols. These simple activation methods are quite sensitive, nondestructive, and require only a short amount of beam time (one minute in most cases) for each sample analysis. The method for determination of nitrogen in aerosols uses a proton beam to induce the $^{14}N(p,\alpha)^{11}C$ reaction. The detection system consists of a Ge(Li) gamma-ray spectrometer. A comparison of nitrogen found by the proton activation method with that found by an independent but destructive combustion method gave an average percent difference of 14% for 17 samples analyzed over a concentration range that spans two orders of magnitude. The sensitivity for detection of nitrogen is approximately 0.1 $\mu g/cm^2$. The method for determination of carbon in aerosols uses a deuteron beam to induce the $^{12}C(d,n)^{13}N$ reaction. The results of the deuteron activation analysis of 15 samples were compared to the results of an independent combustion method. The comparison shows an average percent difference of 10%. The sensitivity for detection of carbon is approximately 0.5 $\mu g/cm^2$. Two methods were developed for determination of oxygen in atmospheric aerosols. One method uses a ^3He beam to induce the $^{16}O(^3He,p)^{18}F$ reaction. The second method uses a proton beam to induce the $^{16}O(p,\alpha)^{13}N$ reacton. The two methods were used to check one another. A comparison of the oxygen found in ten samples by ^3He activation analysis with that found by proton activation analysis shows an average percent difference of 18%. The sensitivity for detection of oxygen is approximately 5 $\mu g/cm^2$ and is primarily limited by the rather large oxygen blank in the silver filter.

12426 (LBL—10280) **Combustion sources of unregulated gas phase nitrogeneous species.** Matthews, R.D.; Sawyer, R.F. (Illinois Univ., Urbana (USA). Dept. of Mechanical and Industrial Engineering; California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1979. Contract W-7405-ENG-48. 68p. Dep. NTIS, PC A04/MF A01.

Published reports which have shown that a wide variety of unregulated nitrogenous species are produced by combustion systems are reviewed and discussed. The total nationwide production is estimated for those species for which sufficient data are available. It is concluded that several noncriteria nitrogen containing species are emitted in significant amounts and that this phenomenon merits further consideration. The emission of gaseous nitrogen compounds from combustion sources is estimated to consist of 76.27% NO, 8.09% NO_2, 15.49% N_20, 0.10% NH_3 and other amines, 0.03% HCN and other nitriles, and 0.02% other nitrogenous species and a mass basis.

12427 (NTIS/PS—79/0690) **Atmospheric modeling of air pollution. Volume 3. 1977-June, 1979 (a bibliography with abstracts). Report for 1977-Jun 1979.** Carrigan, B. (National Technical Information Service, Springfield, VA (USA)). Jul 1979. 267p. NTIS PCN01/MF N01.

Lower atmospheric modeling of air pollution from both mobile and stationary sources are covered in the bibliography. Models cover local diffusion, urban heat islands, precipitation washout, worldwide diffusion, climatology, and smog. Stratospheric modeling concerning supersonic aircraft are excluded. (This updated bibliography contains 258 abstracts, 85 of which are new entries to the previous edition.)

12428 (NTIS/PS—79/0794) **Air quality monitoring. Volume 3. 1977-July, 1979 (a bibliography with abstracts). Report for 1977-Jul 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 259p. NTIS PCN01/MF N01.

The citations from Federally funded research discuss major studies on air pollution monitoring, including site selection, operation criteria, design criteria, calibration, and performance evaluation of the technique or equipment. Different types of pollutants from various sources are covered. (This updated bibliography con-

tains 253 abstracts, 78 of which are new entries to the previous edition.)

12429 (PB—290473) **Balloon-borne particulate sampling for monitoring power plant emissions. Final report, November 1976-July 1978.** Armstrong, J.A.; Russell, P.A.; Williams, R.E. (Denver Research Inst., CO (USA)). Oct 1978. 60p. NTIS, PC A04/MF A01.

The report describes a lightweight remote-controlled sampler, carried aloft by a tethered balloon, that has been developed to collect particulates from the plumes of fossil-fueled power plants at various downwind distances. The airborne sampler is controlled from the ground by a radio transmitter and receiver/servo system. A verification transmitter/receiver system allows monitoring of various commands to the sampler for correct operation. The sampler uses a pump to draw air through a strip of Nuclepore or other filter media. The sampler can be selectively actuated in flight to collect a number of discrete samples on the filter or to take a time-resolved streak sample across a length of the filter. The sampling system was field tested at two sites burning low-sulfur coal, an urban and a rural power plant. The collected samples were analyzed in terms of size, concentration, and composition using scanning electron microscopy/energy dispersive X-ray spectrometry. In general, the particles were spheres with diameters <5 micrometers. Some agglomerates were found. Most of the fly ash was composed of Si and Al, with small amounts of Fe.

12430 (PB—290507) **Modeling of simulated photochemical smog with kinetic mechanisms. Volume 1. Interim report. Interim report, July 1976-July 1978.** Whitten, G.Z.; Hogo, H.; Meldgin, M.J.; Killus, J.P.; Bekowies, P.J. (Systems Applications, Inc., San Rafael, CA (USA)). Jan 1979. Contract EPA-68-02-2428. 332p. NTIS, PC A15/MF A01.

Computer modeling of smog chamber data is discussed in three parts. First, a series of detailed chemical mechanisms were developed to describe the photochemical formation of ozone from nitrogen oxides and the following organic compounds (alone and in various combinations): formaldehyde, acetaldehyde, ethylene, propylene, butane, 1-butene, trans-2-butene, and 2,3-dimethylbutane. Second, a generalized kinetic scheme intended for use in models simulating the formation of ozone in urban atmospheres was refined. The generalized mechanism includes a condensed version of the detailed mechanisms developed in the first part plus a semi-empirical scheme to describe the oxidation of aromatic hydrocarbons. Third, the effects of smog chambers on ozone formation were examined. For this part of the study, similar experiments using nitrogen oxides and propylene in eight different smog chambers were simulated using the detailed propylene mechanism. The main chamber effects identified thus far are apparently due to nitrogen oxides degassing from the walls during experiments and differences between chambers in the spectral distribution of ultraviolet irradiation. Volume 1 contains all textual material.

12431 (PB—290508) **Modeling of simulated photochemical smog with kinetic mechanisms. Volume 2. Interim report appendix. Interim report, July 1976-July 1978.** Whitten, G.Z.; Hogo, H.; Meldgin, M.J.; Killus, J.P.; Bekowies, P.J. (Systems Applications, Inc., San Rafael, CA (USA)). Jan 1979. Contract EPA-68-02-2428. 415p. NTIS, PC A18/MF A01.

Computer modeling of smog chamber data is discussed in three parts. First, a series of detailed chemical mechanisms were developed to describe the photochemical formation of ozone from nitrogen oxides and the following organic compounds (alone and in various combinations): formaldehyde, acetaldehyde, ethylene, propylene, butane, 1-butene, trans-2-butene, and 2,3-dimethylbutane. Second, a generalized kinetic scheme intended for use in models simulating the formation of ozone in urban atmospheres was refined. The generalized mechanism includes a condensed version of the detailed mechanisms developed in the first part plus a semi-empirical scheme to describe the oxidation of aromatic hydrocarbons. Third, the effects of smog chambers on ozone formation were examined. For this part of the study, similar experiments using nitrogen oxides and propylene in eight different smog chambers were simulated using the detailed propylene mechanism. The main chamber effects identified thus far are apparently due to nitrogen oxides degassing from the walls during experiments and differences between chambers in the spectral distribution of ultraviolet irradiation. Volume 2 contains graphs of measured and simulated pollutant concentrations for many smog chamber experiments.

12432 (PB—290557) **Control of volatile organic emissions from manufacture of pneumatic rubber tires.** Zobel, K.J.; Efird, N. (Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards). Dec 1978. 72p. NTIS, PC A04/MF A01.

This document provides the necessary guidance for development of regulations to limit emissions of volatile organic compounds (VOC) from manufacture of pneumatic rubber tire operations. Emissions are characterized and reasonably available control technology (RACT) is defined for each of four major sources: green tire spraying, undertread cementing, tread-end cementing, and bead dipping. Information on cost of control and environmental impact is also included.

12433 (PB—290658) **Evaluation of techniques for measuring biogenic airborne sulfur compounds, Cedar Island field study, 1977.** McClenny, W.A.; Shaw, R.W.; Baumgardner, R.E.; Braman, R.S.; Ammons, J.M. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab.; University of South Florida, Tampa (USA). Dept. of Chemistry). Jan 1979. 138p. NTIS, PC A07/MF A01.

Sulfur in both gaseous and particulate form has been measured near biogenic sources using new measurement techniques. The preconcentration of gaseous sulfur on gold-coated glass beads followed by desorption into a flame photometric detection for sulfur is shown to have a detection limit of 0.1-0.2 ng of sulfur and to allow for speciation of H2S, CH3SH and (CH3)2S at low parts per trillion levels. Ambient levels of NO2 and O3 were found to alter the molecular form of sulfur on the beads unless scrubbed from the sampled air. A collection technique using tandem filters is extended from earlier efforts on fine and coarse aerosol to include collection of SO2 and H2S on chemically coated filters; these filters are analyzed by X-ray fluorescence for sulfur content. Measurements of gases evolved from biogenic sources reveal H2S and (CH3)2S as primary components with significant diurnal variations. Recommendations for further instrument development are given.

12434 (PB—290660) **Regional air pollution study. High volume filter measurements of suspended particulate matter. Final report.** Nelson, E. (Rockwell International Corp., Creve Coeur, MO (USA). Environmental Monitoring and Services Center). Jan 1979. Contract EPA-68-02-2093. 112p. NTIS, PC A06/MF A01.

Ten of the 25 stations making up the Regional Air Monitoring System were equipped with dichotomous samplers and high volume filter samplers for aerosol measurements. The high volume samplers collected samples every third day for 24-hour periods (0000-2400). Sample filters were returned to a chemical laboratory where weights of total suspended particulate (TSP) were determined, and wet chemical analyses performed for sulfates and nitrates. A total of 2358 samples were obtained between March 1975 and March 1977. The report describes both the operation of the sampling network, including equipment maintenance, and analysis and quality control procedures and results. Analyses were made to determine seasonal and spatial variations of the three parameters measured. The station geometric mean concentrations of TSP varied from 33.0 to 90.9 micrograms/cu m, sulfate ranged from 7.0 to 12.7 micrograms/cu m, and nitrate from 2.3 to 3.8 micrograms/cu m. Sulfate showed the greatest seasonal variation, peaking in the summer months, and nitrate the least, with no consistent patterns discernable. An Appendix lists all individual sampling results obtained. These data are stored in the RAPS Data Bank in Research Triangle Park, N.C.

12435 (PB—290859) **Laboratory investigation of the photooxidation and catalytic oxidation of SO2. Final report.** Anderson, R.J.; Pilie, R.J.; Mack, E.J.; Kocmond, W.C. (Calspan Corp., Buffalo, NY (USA)). Jan 1979. Contract EPA-68-02-1785. 88p. NTIS, PC A05/MF A01.

The photooxidation of SO2 in irradiated auto exhaust + SO2 systems, the catalytic oxidation of SO2 in the solution droplets of hazes, clouds and fogs containing several concentrations of heavy metals (Mn(+2) and Fe(+3)), and the oxidation of SO2 in irradiated hazes and fogs containing only trace quantities of heavy metals were studied in a 590 cu m indoor smog chamber. For the irradiated auto exhaust + SO2 systems, SO2 oxidation rates as high as 5 percent/hr were observed. Primary particulates from auto exhaust produced no discernible effect on SO2 oxidation. Catalytic oxidation of SO2 in fogs and hazes was significant under certain conditions, with as much as 6 percent of the available SO2 being oxidized in a 30-minute period. No synergistic effect on the rate of SO2 oxidation was observed from the simultaneous presence of irradiation and a fog or haze.

12436 (PB—290897) **Sampling charged particles with cascade impactors. Final report, April 1977-September 1978.** Farthing, W.E.; Hussey, D.H.; Smith, W.B.; Wilson, R.R. Jr. (Southern Research Inst., Birmingham, AL (USA)). Jan 1979. Contract EPA-68-02-2131. 90p. NTIS, PC A05/MF A01.

The report discusses three sets of experiments which demonstrate that a cascade impactor sampling a charged aerosol may yield a particle size distribution measurement that deviates from the time distribution. The distributions indicated more large particles and fewer small particles than actually existed, due to the particles' attraction to the grounded impactor plates (stages). Although higher charge levels produced larger deviations from the true size distribution, the magnitude of the deviation and the corresponding correction factor for any given charged aerosol are unpredictable. Also, the error was smaller if glass fiber substrates were used as collection surfaces instead of bare metal. For electrostatic precipitators operating at normal charging conditions (an electric field of 400,000 V/m

and a current density of 0.0003 A/sq m/s), the size distribution (measured by the lower stages of an Andersaen cascade impactor with glass fiber substrates) was not significantly different from the true size distribution.

12437 (PB—290899) **Guidelines for particulate sampling in gaseous effluents from industrial processes. Final report, January-September 1978.** Wilson, R.R. Jr.; Cavanaugh, P.R.; Cushing, K.M.; Farthing, W.E.; Smith, W.B. (Southern Research Inst., Birmingham, AL (USA)). Jan 1979. Contract EPA-68-02-2111. 130p. NTIS, PC A07/MF A01.

The report lists and briefly describes many instruments and techniques used to measure the concentration or size distribution of particles suspended in process streams. Standard (well established) methods are described, as well as some experimental methods and prototype instruments. Instruments and procedures for measuring mass concentration, opacity, and particle size distribution are described. Procedures for planning and implementing tests for control device evaluation are also included.

12438 (PB—292038) **Standard air pollution classification network: a thesaurus of terms (as used in the APTIC data base). Second edition. Final report.** Halpin, P. (Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards). Mar 1978. 185p. NTIS, PC A09/MF A01.

This thesaurus of terms contains all of the standardized terminology and rules for its use as applicable to the Air Pollution Technical Information Center (APTIC) bibliographic file on the subject of air pollution. The thesaurus is of use to those who wish to search the APTIC bibliographic file for any particular document or for documents on any stated subject in the air pollution field. The thesaurus would also be useful to anyone wishing to compile a glossary or thesaurus on the subject of air pollution, either as an entity or as part of a broader work on the environment.

12439 (PB—293085) **Washington state air monitoring data for 1977.** (Washington State Dept. of Ecology, Olympia (USA). Air Programs Div.). Jun 1978. 83p. NTIS PC A05/MF A01.

The report contains information in the following areas: control agencies; location of monitoring sites; non-attainment areas; sampling procedures; air quality standards; telemetry system; station coding; meteorological highlights; climatological summary; summary of data by pollutant.

12440 (PB—293106) **Air quality data for metals 1975 from the national air surveillance networks. Final report.** Rhodes, R.C.; Fair, D.H.; Frazer, J.E.; Long, S.J.; Loseke, W.A. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Monitoring and Support Lab.). Oct 1978. 117p. Microfiche copies only.

Particulate pollutant data gathered during calendar year 1975 by the cooperating stations of the National Air Surveillance Networks provide the basis for listing the urban and nonurban concentrations of 11 metallic components of suspended particulate matter. The data are presented as a composite concentration value for each site for each of the four quarters of the calendar year; a yearly average is reported whenever valid data for all four quarters were obtained.

12441 (PB—293119) **The development of mathematical models for the prediction of anthropogenic visibility impairment. Volume I. Final report October 1977-September 1978.** Latimer, D.A.; Bergstrom, R.W.; Hayes, S.R.; Liu, M.; Seinfeld, J.H. (Systems Applications, Inc., San Rafael, CA (USA)). Sep 1978. Contracts EPA-68-01-3947;EPA-68-02-2593. 210p. NTIS PC A10/MF A01.

This report describes a nine-month study to recommend and develop models that predict the contribution of man-made air pollution to visibility impairment in federal Class I areas. Two models were developed. A near-source plume model based on a Gaussian formulation was designed to compute the impact of a plume on visual range and atmospheric coloration. A regional model was designed to calculate pollutant concentrations and visibility impairment resulting from emissions from multiple sources within a region with a spatial scale of 1000 km and a temporal scale of several days. The objective of this effort was to develop models that are useful predictive tools for making policy and regulatory decisions, for evaluating the impacts of proposed new sources, and for determining the amount of emissions reduction required from existing sources, as mandated by the Clean Air Act Amendments of 1977. Volume I of this report contains the main text.

12442 (PB—293120) **The development of mathematical models for the prediction of anthropogenic visibility impairment. Volume II: appendices. Final report October 1977-September 1978.** Latimer, D.A.; Bergstrom, R.W.; Hayes, S.R.; Liu, M.; Seinfeld, J.H. (Systems Applications, Inc., San Rafael, CA (USA)). Sep 1978. Contracts EPA-68-01-3947;EPA-68-02-2593. 519p. NTIS PC A22/MF A01.

This report describes a nine-month study to recommend and develop models that predict the contribution of man-made air pollution to visibility impairment in federal Class I areas. Volume II contains the appendices. The topics are the following: Analysis of visual range in the Northern Great Plains and the Southwest; Atmospheric optics calculation; The chemistry of sulfate formation; Description of the plume visibility model; Plume model sample output; Description of the Northern Great Plains regional model; Application of the regional model to the prediction of visibility impairment in the Northern Great Plains.

12443 (PB—293121) **The development of mathematical models for the prediction of anthropogenic visibility impairment. Volume III: case studies for selected scenarios. Final report October 1977-September 1978.** Latimer, D.A.; Bergstrom, R.W.; Hayes, S.R.; Liu, M.; Seinfeld, J.H. (Systems Applications, Inc., San Rafael, CA (USA)). Sep 1978. Contracts EPA-68-01-3947;EPA-68-02-2593. 98p. NTIS PC A05/MF A01.

This report describes a nine-month study to recommend and develop models that predict the contribution of man-made air pollution to visibility impairment in federal Class I areas. Volume III presents case studies of power plant plume visual impact for a variety of emission, meteorological, and ambient background scenarios.

12444 (PB—293160) **Energy-related air quality monitoring in the western energy resource development area.** Pitchford, M.L.; Snelling, R.N.; Bowen, J.; Pearson, M.; McNelis, D.N. (Environmental Protection Agency, Las Vegas, NV (USA). Environmental Monitoring and Support Lab.). Nov 1978. 62p. NTIS PC A04/MF A01.

This report describes a program designed to create an environmental data base which will be used to assess the air quality impact of energy development in an eight-state region (Arizona, Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah, Wyoming). The program was designed to use and augment existing monitoring activities as well as create new monitoring systems. Some of the activities described are an airborne air quality monitoring system, a regional particulate sampling network, a quality assurance program, a visibility monitoring system, an air quality simulation modeling program, and a program to investigate weather modification effects of energy-related pollutants.

12445 (PB—293164) **Regional air pollution study, emission inventory summarization. Final report.** Littman, F.E. (Rockwell International Corp., Creve Coeur, MO (USA). Environmental Monitoring and Services Center). Jan 1979. Contract EPA-68-02-2093. 103p. NTIS PC A06/MF A01.

As part of the Regional Air Pollution Study (RAPS), data for an air pollution emission inventory are summarized for point and area sources in the St. Louis Air Quality Control Region. Data for point sources were collected for criteria and noncriteria pollutants, hydrocarbons, sulfur trioxide, particle size distribution, and heat. For area sources, data were collected on criteria pollutants, hydrocarbons and heat. All the data have been entered into the RAPS Data Bank. Hourly values are available for all point sources; locations are identified by UTM coordinates (zone 15) to within + or - 10 m. Area sources are assigned to a network of 1989 grid squares of variable size. The emission inventory is applicable for the years 1975 and 1976 and complements the RAPS aerometric data.

12446 (PB—293226) **Hydrocarbons in Houston air. Report for September 1973-April 1974.** Lonneman, W.A.; Namie, G.R.; Bufalini, J.J. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab.). Feb 1979. 44p. NTIS PC A03/MF A01.

Ambient air samples were collected in Houston downtown and industrial areas to determine hydrocarbon composition and concentrations. Twenty-one samples were collected on three days of sampling: September 1, 1973, and January 30 and April 2, 1974. The results of the detailed hydrocarbon analyses of these samples are presented and suggest that both vehicular and industrial sources of hydrocarbons are important. Some of these samples were collected during periods of extremely stagnated meteorological conditions. It was observed that although the total nonmethane hydrocarbons were high, they did not exceed 10 ppmC. Measurements of nitrogen oxides were made for some of these samples. These samples suggested that the NMHC/NOx ratio in the Houston area was not atypical, usually ranging from 10/1 to 20/1.

12447 (PB—293227) **Non-urban hydrocarbon concentrations in ambient air north of houston, texas. Report for jan-apr 78.** Seila, R.L. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab.). Feb 1979. 38p. NTIS PC A03/MF A01.

In January 1978, a study was undertaken at Jones State Forest, 38 miles north of Houston, Texas, to determine the concentrations of non-methane hydrocarbons, methane, and carbon monoxide; to detail the composition of hydrocarbons (especially of the vegetation); and to discover the sources of non-methane hydrocar-

bons. Thirteen 3-hour integrated Tedlar bag samples and five grab samples using stainless steel cans were collected over a 39-hour period. The samples were returned to the Research Triangle Park laboratory for analysis, where the can samples showed lower non-methane hydrocarbon concentration values that did the bag samples. Sources of paraffins (72% of the non-methane hydrocarbons) and the other hydrocarbons were found to be: vehicular exhaust (35%), the forest's vegetation (2%), the city of Houston (22%), and the region between Houston and the forest (32%). Isoprene and alpha-pinene were the vegetative hydrocarbons noted, with the latter showing a distinctive 24-hour cycle of concentration variation.

12448 (PB—293269) **Oxidant formation in the generation of ozone.** Gay, B.W. Jr; Namie, G.R.; Bufalini, J.J. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab.). Feb 1979. 25p. NTIS PC A02/MF A01.

Ozone samples generated by uv photolysis and silent electric discharge upon air or oxygen were examined to determine if other oxidants were formed. Chemical and physical methods (ir and uv spectroscopy) failed to show the presence of such oxidants. Absence of such oxidants was also indicated by the excellent agreement between analytical results from uv photometry and gas phase titration. Ozone measurements by the colorimetric 1 percent neutral buffered potassium iodide method were biased 10-30 percent positive compared to uv photometry. A colorimetric method employing a solution of cyclohexene-dimethanol and ferrous ammonium sulfate (CHD), which is claimed to measure singlet oxygen and/or other oxidants along with ozone, proved to have a different stoichiometry in the presence and absence of oxygen. These latter results were interpreted to mean that the high response of CHD to ozonized air/oxygen streams does not indicate the presence of nonozone oxidants; rather, it reflects a greater-than-stoichiometric response of the CHD reagent to ozone.

12449 (PB—293341) **Ozone calibration and audit by gas phase titration in excess ozone. bendix (trade name) transportable field calibration system, models 8861d and 8861da.** Lumpkin, T.A.; Martin, B.E. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Monitoring and Support Lab.). Feb 1979. 49p. NTIS PC A03/MF A01.

Detailed procedures for the dynamic calibration and audit of chemiluminescence ozone analyzers are presented. The calibrations and audits are performed by means of a gas phase titration technique using the rapid gas phase reaction between nitric oxide and ozone with excess ozone present. The purpose of this report is to aid calibration personnel in performing calibrations and audits in exactly the same manner with identical calibration systems. One of the advantages of the procedures is that chemiluminescence ozone analyzers can be calibrated or audited in the field without the bulky equipment required for the neutral buffered potassium iodide calibration procedure. A second advantage is that more precise results can be obtained.

12450 (PB—293360) **Measurement of PCB emissions from combustion sources. Final report December 1976-December 1978.** Levins, P.L.; Rechsteiner, C.E.; Stauffer, J.L. (Little (Arthur D.), Inc., Cambridge, MA (USA)). Feb 1979. Contract EPA-68-02-2150. 90p. NTIS PC A05/MF A01.

The report describes a gas chromatographic/mass spectrometric (GC/MS) procedure that overcomes problems encountered when using GC procedures (previously used to determine polychlorinated biphenyls (PCBs) in solids and water) on emissions from combustion sources. The GC/MS procedure, which relies on selected mass scanning in restricted regions of the chromatograms, was developed because in the combustion process the distribution pattern of the individual PCBs changes, rendering invalid the pattern matching approach used with the gas chromatographic/electron capture detection (GC/ECD) method.

12451 (PB—293485) **Association between meteorological conditions and high ozone and sulfate concentrations: a 1974 episode in the eastern United States. Report for February-October 1978.** DeMarrais, G.A. (Ross and Baruzzini, Inc., St. Louis, MO (USA)). Feb 1979. 75p. NTIS PC A04/MF A01.

A 1,000,000 sq km area of the Eastern United States had sulfate concentrations exceeding 10 microgram/cu m on July 10, 1974, and there were indications that parts of the area had high concentrations on prior days. The meteorology associated with the high concentrations and correlations of high ozone and sulfate concentrations are discussed. It appeared that slow moving and subsiding air contributed to the high concentrations of both pollutants. Long range transport, as shown by trajectory analyses, was a factor in the problems in most areas, but the worst situations with regards to sulfates were associated with emissions from nearby, upwind sources. While high ozone concentrations were observed immediately prior to high sulfate concentrations in many areas, there were high sulfate concentrations that were not associated with high ozone concentrations. In the latter situation, the high sulfate concentrations were associated with air which had earlier movement over areas with high SO2 emission.

12452 (PB—293599) **Multimedia assessment of pollution potentials of non-sulfur chemical pulping technology. Final report jan-dec 77.** Dallons, V. (Environmental Protection Agency, Corvallis, OR (USA). Corvallis Environmental Research Lab.). Jan 1979. 93p. NTIS, PC A05/MF A01.

This report gives an estimate of the air, water, and solid waste pollution generated by developing and existing non-sulfur pulping techniques that are potentially competitive with kraft pulping. Also developed were energy use and needs estimates for these pulping processes. Processes investigated were soda pulping, soda semichemical pulping, soda pulping followed by oxygen delignification, thermomechanical pulping followed by oxygen delignification, oxygen pulping of wood wafers, chlorine dioxide pulping, solvent pulping and the Rapson process. All of the pulping processes considered develop less water pollutants and less total reduced sulfur emissions than does the kraft process. Sulfur dioxide and particulate emissions vary from process to process, some being greater than that expected from kraft and some less. Sulfur dioxide and particulate emissions largely originate from power boilers. Requirements for power produced from power boilers vary considerably between mill types. Some air pollutants presently not inherent to the production of pulp, such as sodium iodide, hydrochloric acid, and carbon monoxide, are potentially emitted from several of the new pulping processes.

12453 (PB—293665) **Power plant stack plumes in complex terrain: data collected during an aerometric field study. Data file.** Holzworth, G.C.; Coventry, D.H. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab.). Sep 1977. mag taep. Source tape is in ASCII character set. Character set restricts preparation to 9 track one-half inch tape only. Identify recording mode by specifying density only. Call NTIS Computer Products if you have questions. Price includes documentation, PB-293 666.

Air quality and meteorological data collected, processed, and edited during the Clinch River Power Plant Plume Study (June 1976 through September 1977) are contained on one magnetic tape. The thirty-four files on the tape contain data of six types: (1) fixed-station data, (2) mobile ground monitoring data, (3) airborne monitoring data, (4) sulfate measurements, (5) upper air meteorological data, and (6) plant operating data. The fixed-station files contain hourly averages of SO2, NOx, NO2 and NO along with wind and temperature data. Ground mobile files contain pollutant and meteorological data from both stationary and mobile monitoring modes. The airborne files are in the form of a series of traverses across the plume between specified check points. Sulfate measurements were taken at selected times at the fixed stations and by mobile van. The upper-air file contains pibal and T-sonde observations of vertical profiles of temperature, wind speed, and direction. Hourly emission rates of SO2 and NO along with generator loads and stack data are contained on the plant operations file. The order in which the files are organized on the tape, formats for each file type, and a description of the data are contained in Appendix C of the report describing the field study.

12454 (PB—293666) **Power plant stack plumes in complex terrain: description of an aerometric field study. Interim report April 1976-October 1978.** Koch, R.C.; Biggs, W.G.; Cover, D.; Rector, H.; Stenberg, P.F. (Geomet, Inc., Gaithersburg, MD (USA)). Jan 1979. Contract EPA-68-02-2260. 172p. NTIS, PC A08/MF A01.

Air quality and meteorological data collected, processed, and edited during the Clinch River Power Plant Plume Study (June 1976 through September 1977) are contained on one magnetic tape. The thirty-four files on the tape contain data of six types: (1) fixed-station data, (2) mobile ground monitoring data, (3) airborne monitoring data, (4) sulfate measurements, (5) upper-air meteorological data, and (6) plant operating data. The fixed-station files contain hourly averages of SO2, NOx, NO2 and NO along with wind and temperature data. Ground mobile files contain pollutant and meteorological data from both stationary and mobile monitoring modes. The airborne files are in the form of a series of traverses across the plume between specified check points. Sulfate measurements were taken at selected times at the fixed stations and by mobile van. The upper-air file contains pibal and T-sonde observations of vertical profiles of temperature, wind speed, and direction. Hourly emission rates of SO2 and NO along with generator loads and stack data are contained on the plant operations file. The order in which the files are organized on the tape, formats for each file type, and a description of the data are contained in Appendix C of the report describing the field study.

12455 (PB—293726) **Evaluation of the gaussian plume model under stable conditions at three Maryland power plants. Final report.** Bower, R.P. (Martin Marietta Corp., Baltimore, MD (USA). Environmental Technology Center). Mar 1979. 60p. NTIS, PC A04/MF A01.

Model predictions are compared to field measurements of SO2 groundlevel concentrations during stable atmospheric condi-

tions. It was found that, in general, all prediction techniques underestimated the cross wind dispersion. Poor agreement was also obtained between measured and predicted SO2 concentrations.

12456 (PB—293795) **IERL-RTP procedures manual: level 1 environmental assessment (second edition). Final report December 1976-January 1978.** Lentzen, D.E.; Wagoner, D.E.; Estes, E.D.; Gutknecht, W.F. (Research Triangle Inst., Durham, NC (USA)). Oct 1978. Contract EPA-68-02-2156. 279p. NTIS, PC A13/MF A01.

The report gives revised Level 1 environmental assessment procedures (recommended by EPA's Industrial Environmental Research Laboratory, Research Triangle Park) for personnel experienced in collecting and analyzing samples from industrial and energy producing processes. The strategy provides a framework for determining industrial process and stream priorities on the basis of a staged sampling and analysis technique. Level 1 is a screening phase that characterizes the pollutant potential of process influent and effluent streams. The manual is divided into two major sections, according to procedure used. Chapters 3-7 discuss sampling procedures for gases, fugitive emissions, liquids (including slurries), and solids. The remainder of the manual is divided into three chapters on procedures for inorganic, organic, and particle analyses. Chapter II briefly discusses bioassay procedures. Biological assessment techniques are detailed in a companion procedures manual.

12457 (PB—293830) **A preliminary examination of the repeatability of the heavy-duty transient dynamometer emission test. Technical report.** Clemmens, W.B. (Environmental Protection Agency, Ann Arbor, MI (USA)). Jun 1978. 10p. NTIS, PC A02/MF A01.

The heavy-duty transient procedure is a new test procedure, and a preliminary estimate of the accuracy of the test results gathered to date (April 28, 1978) was of paramount interest in evaluating the test procedure. The purpose of this report is to briefly examine the repeatability (errors due to lack of precision) of this new procedure.

12458 (PB—294098) **Current methods to measure atmospheric nitric acid and nitrate artifacts.** Stevens, R.K. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Sciences Research Lab.). Mar 1979. 99p. NTIS, PC A05/MF A01.

Presentations given at a workshop on 'Measurement of Atmospheric Nitrates' (Southern Pines, N.C. October 3-4, 1978) are documented. The authors consider various analytical methods to measure ambient concentrations of nitric acid and artifact nitrate formation.

12459 (PB—294187) **Air quality data - 1978 first quarter statistics.** (Environmental Protection Agency, Research Triangle Park, NC (USA). Monitoring and Data Analysis Div.). Nov 1978. 113p. NTIS, PC A06/MF A01.

This report is a statistical summary report on ambient air quality submitted to EPA from air monitoring operations of State, local and Federal networks in accordance with requirements of the Clean Air Act and EPA Regulations for State Implementation Plans (SIPs). These data represent all ambient air quality data sampled for pollutants that currently have National Ambient Air Quality Standards.

12460 (PB—295386) **Further studies of regional diffusion modeling in the northern great plains. Final report.** Liu, M.; Wojcik, M. (Systems Applications, Inc., San Rafael, CA (USA)). Mar 1979. Contract EPA-68-01-3591. 125p. NTIS, PC A06/MF A01.

In a previous study, a Regional Air Pollution Model was developed to simulate the effect of emissions from major point sources on air quality over long distances. This model was subsequently applied to the Northern Great Plains to assess the regional impact of existing and proposed energy developments in that area. This report continues that study by investigating methods for characterizing wind field and mixed layer diffusivity in mesoscale air quality modeling. After a review of pertinent theoretical and observational studies, the geostrophic wind and a scheme first proposed by Smagorinsky(1963) for horizontal eddy diffusivities were selected. A bicubic spline fit was used to interpolate the geopotential height data needed for implementation of this scheme. This method was used to compute the wind fields and horizontal diffusivities for the three time periods studied in the previous efforts, and the Regional Air Pollution Model was subsequently exercised using the new meteorological data.

12461 (PB—297384) **Effects of increases in carbon dioxide in the earth's atmosphere: a synthesis.** Smith, S. (Biospherics Inc., Rockville, MD (USA)). Feb 1979. Contract NOAA-41-USC-252C(3). 17p. NTIS, PC A02/MF A01.

If left unchecked, increasing levels of CO2 may eventually have far-reaching consequences on a global scale. Many scientists forecast a CO2-dependent increase in temperature, with concomitant effects on weather, climate, terrestrial and marine ecology, and other dimensions of the environment. These changes may have serious implications for human industrial activities such as agriculture, fishing, and energy production and use. More research is needed to define the problem and to pinpoint the decisionmaking time frame before the problem becomes unsolvable. To reduce uncertainties and to assess the seriousness of the matter, scientists point to the need for a well-coordinated, interdisciplinary, international program. Practical ways of reducing the CO2 content of the air, either by direct removal from the air or by 'scrubbing' the effluent of powerplants, should also be investigated. The effects of continued increases in atmospheric CO2 may have implications for many diverse aspects of national and international policy. If the issue is ignored, CO2, until now a seemingly harmless trace component of the atmosphere, could eventually exert profound influences.

12462 (PB—297801) **Study of the nature of ozone, oxides of nitrogen, and nonmethane hydrocarbons in Tulsa, Oklahoma. Volume II. Data tabulation.** Eaton, W.C.; Dimmock, F.E. (Research Triangle Inst., Durham, NC (USA)). Apr 1979. Contract EPA-68-02-2808. 479p. NTIS, PC A21/MF A01.

This volume contains tabulated ambient air quality and meteorological data resulting from surface and airborne measurements made in Tulsa, Oklahoma during July, August and September 1977. Also included are figures which illustrate the monitoring network and aircraft flight tracks followed during the airborne measurements program.

12463 (PNL-SA—7421) **Turbidity variations in the Lower Columbia Basin.** Laulainen, N.S. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jan 1979. Contract EY-76-C-06-1830. 7p. (CONF-790445—9). Dep. NTIS, PC A02/MF A01.

From 19. annual meeting of the institute of environmental sciences; Seattle, WA, USA (29 Apr 1979).

Turbidity variations in the Lower Columbia Basin appear to be related to agricultural activity and synoptic meteorological conditions. Changes in particulate size distribution are apparent in the turbidity color dependence. Turbidities at Hanford have shown considerable variation since 1974.

12464 (PNL-SA—7461) **Redistribution of a layer of HTO by rainfall.** Dana, M.T.; Davis, W.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jan 1979. Contract EY-76-C-06-1830. 8p. (CONF-790445—10). Dep. NTIS, PC A02/MF A01.

From 19. annual meeting of the institute of environmental sciences; Seattle, WA, USA (29 Apr 1979).

A uniform layer of HTO, when encountering a warm or cold front with rainfall, may be simultaneously lifted by frontal air motions over the front and lowered by reversible HTO scavenging. Illustrative calculations show that under typical conditions a layer of HTO bordering the ground may move through a front without rising. The attendant rainfall in this case causes a decay in the concentration which may be significant over the time of frontal pass through. A short case study was included to test whether plume washdown can cause changes in the average air concentration.

12465 (PNL-SA—7486) **Long-range transport of pollutants in the Pacific Northwest.** Sandusky, W.F.; Eadie, W.J.; Drewes, D.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jan 1979. Contract EY-76-C-06-1830. 6p. (CONF-790445—8). Dep. NTIS, PC A02/MF A01.

From 19. annual meeting of the institute of environmental sciences; Seattle, WA, USA (29 Apr 1979).

Air quality impacts associated with future utility and industrial siting as defined by the business as usual scenario have been analyzed. This analysis is based on assumptions regarding emission rates, implementation of Best Available Current Technology (BACT), siting data generated by the ORNL regional studies program, and a regional scale transport, transformation, and removal model for SO_2, sulfates, and particulates. Results of this assessment show that industrial siting in the Portland-Seattle area may be constrained due to regulations for Prevention of Significant Deterioration (PSD) in terms of both incremental SO_2 and particulate concentrations at sites near Class I areas. Topography influences the concentration patterns of the pollutants. Generally, these patterns reflect the wind flow characteristics but are modified by dry deposition processes. Maximum predicted ground-level concentrations of SO_2, sulfate, and particulates occur with 63 km of the source. Over 80% of the sulfur emissions in the Pacific Northwest US will ultimately be deposited within the region. The percentage deposited for industrial sources is slightly higher than utility sources due to the lower effective release height.

12466 (PNL-SA—7576) **Aerosol, trace elements and visibility measurements in mountainous terrain.** Orgill, M.M.; Laulainen, N.S.; Drewes, D.R.; Lee, R.N. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jan 1979. Contract EY-76-C-06-1830. 10p. (CONF-790445—7). Dep. NTIS, PC A02/MF A01.

From 19. annual meeting of the institute of environmental sciences; Seattle, WA, USA (29 Apr 1979).

A report is presented on an initial effort to collect data on the relationships between aerosols, trace elements, and visibility in

mountainous terrain and air pollutants from existing industrial, urban, agricultural and transportation sources in the Pacific Northwest states of Washington, Oregon, and Idaho. Data were obtained by airborne instruments. Twelve samping flights provided data on scattering extinction coefficient, trace elements, sulfate, and ozone during relatively good (~ 25 km) prevailing visibility conditions. Over 80% of the sample flights indicated that the meteorological range was 20 km or more. Four or five of the sampling flights indicated the presence of visibility reducing haze. Relatively higher concentrations of certain crustal and anthropogenic trace elements and sulfate (associated with high relative humidities) resulted in degradation of meteorological range in the foothills of Cascades, Snoqualmie Pass and Kittitas Valley and Columbia River Gorge. These 12 sampling flights are not representative of the wide range of visual conditions that can exist in mountainous regions.

12467 (UCD—472-125, pp 9-16) **Collection and handling of samples of aerosols produced in coal utilization for evaluation of biomedically relevant properties.** Raabe, O.G. Oct 1979.

In Annual report, 1978-1979.

Releases of airborne toxicants may occur at various stages of coal combustion and conversion technologies. These will usually be complex mixtures of both organic and inorganic aerosols and vapors that need to be studied and evaluated in the perspective of the potential biological fate and effects if inhaled. During collection, handling, and evaluation of samples, extreme care based on careful planning is needed to insure representativeness, stability, and cleanliness, and to prevent the introduction of artifacts. Emphasis is on biological testing as an important application of these samples.

12468 (UCD—472-125, pp 17-19) **Quantification of the surface concentration of cadmium in fly ash.** Silberman, D.; Fisher, G.L. Oct 1979.

In Annual report, 1978-1979.

To evaluate further elemental distribution within fly ash particles detailed fractional solubility studies were performed. This report specifically describes efforts to quantify the relative surface and matrix distributions of cadmium. Approximately 60% of the cadmium in fly ash appears to be surface-associated.

12469 (UCD—472-125, pp 20-21) **Elemental analysis of individual morphological particle classes in coal fly ash.** Fisher, G.L.; Hayes, T.L.; Lai, C.; Prentice, B.A. Oct 1979.

In Annual report, 1978-1979.

Cooperative studies with Donner Laboratory, UC Berkeley, have demonstrated the matrix heterogeneity of individual fly ash particels. Studies are under way to quantify the elemental composition of light-microscopically determined particle morphologies. This research will also provide insight into the mechanism of fine particle formation and potential toxicity associated with unique particulate compositions.

12470 (UCD—472-125, pp 26-32) **Comparison of fractionated electrostatic-precipitator hopper ash and stack-collected size-classified fly ash.** Fisher, G.L.; Raabe, O.G.; Prentice, B.A.; Silberman, D. Oct 1979.

In Annual report, 1978-1979.

In an effort to define the health hazards from coal combustion fly ash, two sampling methods were compared for analyzing particle size and chemical composition as well as morphological characteristics of the aerosols. Relatively good agreement was obtained. (PCS)

12471 (UCD—472-125, pp 33-39) **Sample collection of emissions and effluents from industrial coke ovens.** Kimble, B.J.; Fisher, G.L.; Chrisp, C.E.; Jennings, W.L.; Lammert, J.E.; Raabe, O.G.; Teague, S.V. Oct 1979.

In Annual report, 1978-1979.

Equipment has been designed and constructed for the collection of potentially toxic emissions from an industrial coking plant. Gaseous and particulate samples as well as coal, coal tars and oils were collected from various locations around a commercial coke oven and its associated by-products area. Chemical characterization studies and biological testing using the Ames mutagenicity assay are currently in progress.

12472 (N—79-19478) **Application of interferential correlation of spectrum to the detection of atmospheric pollutants.** Fortunato, G. Translated from *J. Opt.;* **9**: No. 5, 281-290(1978). 25p. NTIS PC A02/MF A01.

The general correlation principles for spectra and spectra derivatives are studied by using the Fourier transform of the spectral distribution of energy from a source illuminating a double beam interferometer with transverse splitting by dividing luminance. In this correlation technique, the use of such an interferometer has the advantage of greater luminosity as compared with a slit spectrometer. However, the correlation example indicates that it is necessary to adapt the correlator to the particular case considered, in order to obtain the best gain in the signal to noise ratio. In the case of sulfur dioxide detection, a very simple mounting which could be used in some interesting industrial applications was developed. This mounting can be used each time that the substance to be analyzed has a quasi-periodic absorption spectrum: in particular this is often the case with absorption spectra of gases, and a mounting identical to the one described for sulfur dioxide proved to be effective in the detection of nitrogen oxides.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 11366, 11369, 11370, 12502, 12504, 12511, 12625

12473 (AD-A—068330) **Measurements of atmospheric ^{222}Rn at San Nicolas Island and over nearby California coastal areas during CEWCOM-78. Memorandum report.** Larson, R.E.; Kasemir, W.; Bressan, D.J. (Naval Research Lab., Washington, DC (USA)). 14 Mar 1979. 14p. NTIS, PC A02/MF A01.

Shipboard and island measurements show that clean maritime air prevailed over San Nicolas Island, California, for two periods of a day or more each during the twelve days of data collection and moderately continental air prevailed for the remainder of the time. Moderately continental air was encountered out to 200km from shore on 8 and 9 May on a dogleg course from Monterey to the San Nicolas Island area. Maritime air was encountered throughout the direct return trip along the coast, showing that the relative continental/maritime nature of the air at a given location in the area is more dependent upon prevailing winds than on distance from land. Radon measurements at the NRL tower site on San Nicolas Island were in good agreement with shipboard data throughout the area, suggesting a relatively uniform distribution of air over a large area, whether it be maritime or moderately continental. The moderately continental conditions prevailing at San Nicolas Island are not unlike those previously encountered for one or more days in remote Pacific areas in air of Asian origin.

12474 (BNL—51066, pp 45-47) **Monitoring of radioiodine from releases from contaminant accidents.** Distenfeld, C.H.; Klemish, J.R. Oct 1979.

In Safety and Environmental Protection Division. Progress report, January 1, 1976-December 31, 1978.

Emergency Monitoring projects covered are: Monitoring of Radioiodine from Releases from Containment Accidents; An Inorganic Radioiodine Absorber with Low Noble Gas Retention; and High Efficiency Mixed Species Radioiodine Air Sampling, Readout, and Dose Assessment System.

12475 (DP—1543) **Calculation of particulate dispersion in a design-basis tornadic storm from the General Electric Vallecitos Nuclear Center, Vallecitos, California.** Pepper, D.W. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Nov 1979. Contract EY-76-C-09-0001. 28p. Dep. NTIS, PC A03/MF A01.

A three-dimensional numerical model is used to calculate ground-level air concentration and deposition (due to precipitation scavenging) after a hypothetical tornado strike at the General Electric Vallecitos Nuclear Center at Vallecitos, California. Plutonium particles less than 20 μm in diameter are assumed to be lifted into the tornadic storm cell by the vortex. The rotational characteristics of the tornadic storm are embedded within the larger mesoscale flow of the storm system. The design-basis translational wind values are based on probabilities associated with existing records of tornado strikes in the vicinity of the plant site. Turbulence exchange coefficients are based on empirical values deduced from experimental data in severe storms and from theoretical assumptions obtained from the literature. The method of moments is used to incorporate subgrid-scale resolution of the concentration within a grid cell volume. This method is a quasi-Lagrangian scheme which minimizes numerical error associated with advection. In all case studies, the effects of updrafts and downdrafts, coupled with scavenging of the particulates by precipitation, account for most of the material being deposited within 20 to 45 km downwind of the plant site. Ground-level isopleths in the x-y plane show that most of the material is deposited behind and slightly to the left of the centerline trajectory of the storm. Approximately 5% of the material is dispersed into the stratosphere and anvil section of the storm.

12476 (DP—1544) **Calculation of particulate dispersion in a design-basis tornadic storm from the Exxon Nuclear Company, Richland, Washington.** Pepper, D.W. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Jul 1978. Contract EY-76-C-09-0001. 27p. Dep. NTIS, PC A03/MF A01.

A three-dimensional numerical model is used to calculate ground-level air concentration and deposition (due to precipitation scavenging) after a hypothetical tornado strike at the Exxon Nuclear Company at Richland, Washington. Plutonium particles less than 20

μm in diameter are assumed to be lifted into the tornadic storm cell by the vortex. The rotational characteristics of the tornadic storm are embedded within the larger mesoscale flow of the storm system. The design-basis translational wind values are based on probabilities associated with existing records of tornado strikes in the vicinity of the plant site. Turbulence exchange coefficients are based on empirical values deduced from experimental data in severe storms and from theoretical assumptions obtained from the literature. The method of moments is used to incorporate subgrid-scale resolution of the concentration within a grid cell volume. This method is a quasi-Lagrangian scheme which minimizes numerical error associated with advection. In all case studies, the effects of updrafts and downdrafts, coupled with scavenging of the particulates by precipitation, account for most of the material being deposited within 20 to 45 km downwind of the plant site. Ground-level isopleths in the x-y plane show that most of the material is deposited behind and slightly to the left of the centerline trajectory of the storm. Approximately 5% of the material is dispersed into the stratosphere and anvil section of the storm.

12477 (EGG—1183-1691) **Aerial Radiological Measuring System (ARMS): systems, procedures and sensitivity (1976).** Boyns, P.K. (EG and G, Inc., Las Vegas, NV (USA)). Jul 1976. Contract EY-76-C-08-1183. 89p. Dep. NTIS, PC A05/MF A01.

This report describes the Aerial Radiological Measuring System (ARMS) designed and operated by EG & G, Inc., for the Energy Research and Development Administration's (ERDA) Division of Operational Safety with the cooperation of the Nuclear Regulatory Commission. Designed to rapidly survey large areas for low-level man-made radiation, the ARMS has also proven extremely useful in locating lost radioactive sources of relatively low activity. The system consists of sodium iodide scintillation detectors, data formatting and recording equipment, positioning equipment, meteorological instruments, direct readout hardware, and data analysis equipment. The instrumentation, operational procedures, data reduction techniques and system sensitivities are described, together with their applications and sample results.

12478 (EGG—1183-2149) **ARMS New Hampshire area special aeroradioactivity survey.** Reskovac, R.R.; Trundle, A.S. III. (EG and G, Inc., Santa Barbara, CA (USA)). Jun 1967. Contract EY-76-C-08-1183. 54p. Dep. NTIS, PC A04/MF A04.

EG and G measured the radioactivity in the White Mountains area of New Hampshire, using the Aerial Radiation Measurements System (ARMS). Particular attention was give to the areas containing formations of Conway granite. Gross-count and spectral measurements were made, and these data are presented in relation to the known geology of the area. Various other methods of data collection were employed and are briefly evaluated in this report.

12479 (LA—8153-PR) **Aerosol sampling and characterization for hazard evaluation. Progress report, October 1, 1977-September 30, 1978.** Scripsick, R.C.; Tillery, M.I.; Stafford, R.G.; Romero, P.O. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 16p. Dep. NTIS, PC A02/MF A01.

Measurements of the dilution of air contaminants between worker breathing zone and area air samplers were made by releasing a test fluorescent aerosol in workrooms equipped with aerosol surveillance systems. These data were used to evaluate performance and suggest improvements in design of alarming air monitor systems. In one workroom studied, average half-hour breathing zone air concentration needed to trigger alarm was found to be 960 times the maximum permissible air concentration for occupational exposure to soluble ^{239}Pu (MPC/sub a/). It was shown that alternative monitor placement in this room could result in decreasing average triggering concentration to 354 times the MPC/sub a/. Analysis of data from impaction-autoradiographic sizing comparison studies showed average disintegration to track ratio called track efficiency factor, to be 2.7 +- 0.4.

12480 (ORNL/TM—6751) **Estimation of North American population doses resulting from radon-222 release in western United States: methodology.** Fields, D.E.; Travis, C.C.; Watson, A.P.; McDowell-Boyer, L.M. (Oak Ridge National Lab., TN (USA)). Dec 1979. Contract W-7405-ENG-26. 57p. Dep. NTIS, PC A04/MF A01.

The report represents a compilation of computer codes used to estimate potential human exposures and inhalation doses due to unit releases of ^{222}Rn from uranium milling sites in western United States. The populations considered for potential exposure to risk from ^{222}Rn and associated daughters are the inhabitants of North America between 20° and 60° North latitude. The primary function of these codes is to integrate spatially atmospheric radionuclide concentrations with current population data for the geographic area under consideration. It is expected that these codes will be of assistance to anyone interested in assessing nuclear or nonnuclear population exposures over large geographic areas.

12481 (PNL—3222) **Master schedule for CY-1980 Hanford Environmental Surveillance Routine Program.** Blumer, P.J.; Houston, J.R.; Eddy, P.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Dec 1979. Contract EY-76-C-06-1830. 41p. Dep. NTIS, PC A03/MF A01.

The current schedule of data collection for the routine environmental surveillance program at the Hanford Site is presented. The enviromental surveillance program objectives are to evaluate the levels of radioactive and nonradioactive pollutants in the Hanford environs, as required in Manual Chapter 0513, and to monitor Hanford operations for compliance with applicable environmental criteria given in Manual Chapter 0524 and Washington State Water Quality Standards. Data are reported on the following topics: air; Columbia River; sanitary water; surface water; ground water; foodstuffs; wildlife; soil and vegetation; external radiation measurement; portable instrument surveys; and surveillance of waste disposal sites;

SITE RESOURCE AND USE STUDIES

12482 (BNL—51058) **Analytical summary of experimental data from two years of hourly sequential precipitation samples at Brookhaven National Laboratory.** Raynor, G.S.; Hayes, J.V. (Brookhaven National Lab., Upton, NY (USA)). May 1979. Contract EY-76-C-02-0016. 95p. Dep. NTIS, PC A05/MF A01.

Hourly precipitation samples were collected at Brookhaven National Laboratory from June 1976 through May 1978 with the Brookhaven Automatic Sequential Precipitation Sampler. Conventional meteorological data were recorded for each sample period. The samples were analyzed for pH, conductivity, and concentrations of sulfate, nitrogen, ammonium, sodium, and chloride ions. Ratios of selected ions, excess conductivity above the H^+ contribution, and excess sulfate and chloride above the seawater ratio were calculated and treated as additional variables. Statistical analyses were performed of the relationships between selected chemical variables and between them and meteorological conditions. Rainfall rate was also analyzed in terms of other meteorological variables. Because a number of units were changed after publication of an earlier report (BNL 50826), the results (presented in a series of tables) are given for each year separately and for both years jointly.

12483 (PB—290505) **Carbon monoxide study - Seattle, Washington, October 6-November 2, 1977. Part 1. Executive summary report.** Wilson, C.B.; Schweiss, J.W. (Environmental Protection Agency, Seattle, WA (USA). Surveillance and Analysis Div.). Dec 1978. 40p. NTIS, PC A03/MF A01.

This report is a summary of EPA 910/9-78-054b, a study of the carbon monoxide problem in downtown Seattle.

12484 (PB—290506) **Carbon monoxide study - Seattle, Washington, October 6-November 2, 1977. Part 2. Final report.** Wilson, C.B.; Schweiss, J.W. (Environmental Protection Agency, Seattle, WA (USA). Surveillance and Analysis Div.). Dec 1978. 169p.

To obtain additional information on the magnitude and spatial extent of the carbon monoxide problem in downtown Seattle, a 20-day study was conducted involving 36 outdoor sites, five indoor sites, and two pedestrian routes. Bag samples were analyzed by an electrochemical oxidation method. Results for one eight-hour period daily (two consecutive four-hour samples) were compared for the outdoor study sites and for five routinely operated permanent monitors in the central business district. The permanent monitoring network adequately represented the highest eight-hour average CO concentration measured during the study period (about 16 ppm), but not the highest frequency of exceedences of the 9.0 ppm standard (80% of the days at one study site). The carbon monoxide problem occurred throughout the downtown commercial district with exceedences noted at least once at 22 of the study sites. Indoor CO concentrations were usually lower than at adjacent outdoor sites. Changes in average indoor and outdoor levels of CO frequently coincided. Detailed descriptions of methods and discussion of findings are included as well as tables of data obtained during the study.

12485 (PB—293798) **Highway air quality impact appraisals. Volume I. Introduction to air quality analysis. Final report.** Pollack, R.I.; Tesche, T.W.; Reynolds, S.D.; Hillyer, M.J.; Jerskey, T.N. (Systems Applications, Inc., San Rafael, CA (USA)). Jun 1978. Contract DOT-FH-11-9143. 417p. NTIS, PC A18/MF A01.

This report is the first of a two volume series intended to provide transportation planners and engineers with guidance on how to perform air quality analyses. Volume I presents basic information useful for analyzing local or regional air quality impacts. Subjects discussed include basic characteristics, sources, removal processes, and air quality standards for five pollutants--hydrocarbons, nitrogen oxides, sulfur oxides, particulates, and photochemical oxidants; emissions, control devices, and legislation on vehicular emissions; nonvehicular anthropogenic and natural sources of those five pollutants; construction of emissions inventories; relative contributions of vehicular emissions to air quality at regional, urban, and roadway spatial scales; physical and chemical processes that affect pollutant concentrations; an assessment of types of air quality models, includ-

ing algebraic (Gaussian), trajectory, and grid numerical models; and the design and use of air quality monitoring programs. The treatment of these issues is designed specifically for the highway planner or engineer who is required to perform air quality evaluations of transportation or land use plans. A glossary is included. Volume I may be useful as a general reference work, particularly on the subjects of emissions, atmospheric processes, and air quality models.

12486 (PB—293799) **Highway air quality impact appraisals. Volume II. Guidance for highway planners and engineers. Final report.** Pollack, R.I.; Tesche, T.W.; Austin, T. (Systems Applications, Inc., San Rafael, CA (USA)). Jun 1978. Contract DOT-FH-11-9143. 163p. NTIS, PC A08/MF A01.

This volume presents guidance for transportation planners and engineers on evaluating the air quality impact of a land use or transportation plan. The various laws that require such an evaluation are reviewed. The technical procedures used in transportation planning are presented briefly, and their value in providing input for an air quality analysis is described. Techniques for compiling emissions inventories and for predicting resultant air quality are also discussed. The various issues that arise in evaluating land use plans, transportation policies, and facility and operation plans at both regional and subregional levels are described, including the selection of the appropriate spatial and temporal scales for the analysis, the accuracy necessary in the analysis methods, the application of screening procedures to determine the level of analysis required, the comparison of air quality predictions to legal requirements on air quality, and the reporting of modeling results. The treatment is designed to familiarize the highway planner or engineer with the issues that must be considered and allow him to determine the appropriate analysis method.

12487 (UCRL—52837) **Numerical wind field model validation for a complex terrain area in the vicinity of Lawrence Livermore Laboratory.** Porch, W.M.; Walker, H.; Veith, C.R.; Dickerson, M.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Sep 1979. Contract W-7405-ENG-48. 35p. Dep. NTIS, PC A03/MF A01.

MATHEW, a mass-consistent wind field model including topography, was tested using statistically selected data stations in the region of Lawrence Livermore Laboratory (LLL). Predicted versus measured winds were compared for data taken across a windy pass (Patterson Pass) in the hills 3 km east of LLL. The topographic scale and the number of selected stations were varied to assess their relative impact on the agreement between the winds predicted by the model and those measured at Patterson Pass. The test results for a one-hour data set show that the model underestimates the measured winds by 25% and the wind energy by a factor of 2.4, with little dependence on topographic scale and some dependence on which data stations were included in the model; however, high winds were predicted in high wind areas. MATHEW's potential as a prognostic model for accurately estimating high wind speeds in complex terrain can be enhanced, if there are improvements in subgrid placement of data stations, if objective wind field analysis is applied to horizontal interpolation where a time history of the data stations used in the model exists, and if there is further improvement of calculational procedures.

REGULATIONS

REFER ALSO TO CITATION(S) 11123, 12496

12488 (PB—290715) **Attainment and maintenance of sulfur dioxide standards in Puerto Rico. Final report.** (Engineering-Science, Inc., McLean, VA (USA)). Oct 1978. 40p. NTIS, PC A03/MF A01.

This study is concerned with the predictions of sulfur dioxide air quality levels in Puerto Rico for the years 1976 and 1990. Emission inventories for the base year for both point and area sources had been compiled in previous studies completed by ES. This data base was recently updated using information provided by EQB in October 1977. Growth estimates for the projection year were obtained from industry and government officials and represent the best estimates of future industrial production and domestic activity on the island.

12489 (PB—292003) **Office of Research and Development Program Guide, fiscal year 1979. Report for 1 October 1978-30 September 1979.** (Environmental Protection Agency, Washington, DC (USA). Office of Research and Development; JRB Associates, Inc., McLean, VA (USA)). Jan 1979. 84p. NTIS, PC A05/MF A01.

The Program Guide provides the public with information on the Office of Research and Development's current extramural research program. It describes each of the major budget units, the funds associated with each, and the responsible laboratory (ies). In addition there are several indices which allow the user to refer to these units by media (air, water, etc.) function (health effects, control technology, etc.), or by a given laboratory's areas of responsibilities.

12490 (PB—293587) **The Clean Air Act: its relation to fish and wildlife resources. Topical briefs: Fish and wildlife resources and electric power generation, no. 8.** Avery, M.; Schreiber, R.K. (National Plant Power Team, Ann Arbor, MI (USA)). Jan 1979. 20p. NTIS, PC A02/MF A01.

Recent Federal air quality legislation is reviewed, with special emphasis on the 1977 Amendments to the Clean Air Act, particularly those aspects concerning fish and wildlife resources. Participation by fish and wildlife biologists in the implementation of provisions of the 1977 Amendments is discussed, and future research needs are identified.

12491 (PB—294664) **State and local grant awards listing awards during October-March fy 1978.** (Environmental Protection Agency, Washington, DC (USA). Grants Administration Div.). Jan 1979. 280p. NTIS, PC A13/MF A01.

This publication lists the grant awards offered by EPA during the period of October - March FY 1978 for State and Local grant programs.

12492 (PB—297506) **Inspection/maintenance program options for Iowa, Kansas, and Nebraska. Executive summary. Final report.** Derr, K.; Eckler, J.; Farkas, A.; Magro, W.; Suryawanshi, S. (Booz, Allen and Hamilton, Inc., Bethesda, MD (USA)). Oct 1978. Contract EPA-68-02-2544. 11p. NTIS, PC A02/MF A01.

This report presents an analysis of alternative motor vehicle emission inspection and maintenance programs for the following metropolitan areas: Davenport, Iowa; Des Moines, Iowa; Omaha, Nebraska-Council Bluffs, Iowa; Wichita, Kansas; and Johnson and Wyandotte Counties in Kansas (Kansas City area). The study methodology utilized is described. The study included collecting data, determining criteria for selecting alternative program configurations, screening program options, and evaluating alternative configurations selected through the screening process. Program alternatives were evaluated in terms of emissions reductions attainable, geographic coverage, effective motor vehicle population, inspection frequency, consumer protection, quality assurance, costs and financial feasibility. The ease of implementing different alternatives was also studied.

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

REFER ALSO TO CITATION(S) 12419, 12420

12493 (FWS/OBS—78/9) **Ecological characterization study of the Chenier Plain coastal ecosystem of Louisiana and Texas. Volume I. Narrative report.** Gosselink, J.G.; Cordes, C.L.; Parsons, J.W. (Louisiana State Univ., Baton Rouge (USA). Center for Wetland Resources; Fish and Wildlife Service, Slidell, LA (USA)). Aug 1979. 302p. Fish and Wildlife Service, Slidell, LA.

Socioeconomic and environmental information on the subject area was collected, reviewed, and synthesized to produce this volume. The present physical setting of the Chenier Plain is described, as well as the geological history of the region. The effects of agricultural and oil and gas industries on the natural (biological) resources in each of six drainage basins are discussed. Habitat types in the Chenier Plain are described, and the impact of human activities on them is evaluated. The conversion of habitats from one type to another over a twenty-year period is documented. Life history information is provided for many of the important fish and wildlife species in the ecosystem.

12494 (FWS/OBS—78/10) **Ecological characterization study of the Chenier Plain coastal ecosystem of Louisiana and Texas. Volume II. Appendixes.** Gosselink, J.G.; Cordes, C.L.; Parsons, J.W. (Louisiana State Univ., Baton Rouge (USA). Center for Wetland Resources; Fish and Wildlife Service, Slidell, LA (USA)). Aug 1979. 408p. Fish and Wildlife Service, Slidell, LA.

Basic data sources are listed separately for geology, hydrology, meteorology, chemistry, socioeconomics, impact analysis and eight biological categories. Production figures are presented for oil and gas, agriculture, fisheries, and fur trapping. Waterfowl species, shrubs and other plants, representative vertebrates and benthos, zooplankton, and land birds are listed for the appropriate habitats of the Chenier Plain. Hydrological data include phosphorus loading rates, water discharges, and habitat change matrixes for each basin.

12495 (FWS/OBS—78/11) **Ecological characterization study of the Chenier Plain coastal ecosystem of Louisiana and Texas. Volume III. Atlas.** Gosselink, J.G.; Cordes, C.L.; Parsons, J.W. (Louisiana State Univ., Baton Rouge (USA). Center for Wetland Resources;

Fish and Wildlife Service, Slidell, LA (USA)). Aug 1979. 11p. Fish and Wildlife Service, Slidell, LA.

The purpose of this ecological characterization was to compile existing information about the biological, physical, and social sciences for the Chenier Plain of Louisiana and Texas. Volume III (Atlas) of the three-volume report consists of the following eleven plates (maps): Plates 1A and 1B - index maps; Plate 2 - The Pleistocene erosional surface; Plates 3A and 3B - Chenier Plain habitat groups; Plates 4A and 4B - Chenier Plain wetland habitats; Plates 5A and 5B - canals and point source discharges; and, Plates 6A and 6B - special features (birdnesting colonies, archeological sites, refuges and oyster reefs). The letter A denotes the western portion of the Chenier Plain, and B denotes the eastern portion. (JGB)

12496 (LA—8098-MS) **Regional Issue Identification and Assessment (RIIA): an environmental evaluation of the EIA Mid-Mid Scenario for Federal Region 8.** (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 128p. Dep. NTIS, PC A07/MF A01.

This Regional Issue Identification and Assessment (RIIA) study evaluates the environmental impacts associated with future energy development in Federal Region 8 (Montana, North and South Dakota, Wyoming, Utah, and Colorado). The impacts described are for 1985 and 1990 and are based on a national energy scenario that assumes medium energy demand and fuel supply through 1990, but does not incorporate the policies of the National Energy Act (NEA). The scenario, known as the Projection Series C or the Trendlong Mid-Mid Scenario, is one of six possible energy futures that have been produced by the Energy Information Administration of the Department of Energy for the Department's 1977 annual report to Congress. All of these possible energy futures are based on the assumption that electric power is generated in the federal region where it is used. This assumption has the effect of understating actual production levels and environmental impacts for each of the issues in the region. This report's Key Findings and Conclusions sections synopsize the study's results.

RADIOMETRIC TECHNIQUES

REFER ALSO TO CITATION(S) 12692

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 11129, 12669, 12673

12497 (BNL—51066, pp 17-18) **Surface analysis techniques and their use in pollution detection and measurement.** Varma, M.N.; Baum, J.W. Oct 1979.

In Safety and Environmental Protection Division. Progress report, January 1, 1976-December 31, 1978.

Fundamental Environmental Studies includes: Surface Analysis Techniques and Their Use in Pollution Detection and Measurement; and Single Molecular Oxygen Reaction Rate Studies.

12498 (DOE/SR/00870—9) **Reforestation of borrow pits by use of specific mycorrhizal fungi, soil amendments and site preparation. Annual progress report.** Berry, C.R. (Forest Service, Athens, GA (USA). Southeastern Forest Experiment Station). Aug 1979. Contract EY-76-A-09-0870. 6p. Dep. NTIS, PC A02/MF A01.

Third-year results are presented from 3 separate studies concerned with reclamation of borrow pits using specific mycorrhizal fungi and various soil amendments. Study one demonstrates that container-grown loblolly pine seedlings grow well when the borrow pit is amended with sewage sludge, but not when amended with inorganic fertilizer applied at a rate of 500 lbs/A 10-10-10 with 2000 lbs/A of lime. Loblolly seedlings with Pisolithus ectomycorrhizae produced significantly more volume per plot than seedlings with Thelephora ectomycorrhizae or control seedlings with few or no ectomycorrhizae, on sewage sludge plots. On fertilizer plots Pisolithus and Thelephora trees grew equally well, but Pisolithus trees grew better than control plots. Study two was installed to test the relative soil amendment value of sewage sludge alone and with bark, bottom furnace ash or both and fertilizer and lime alone and with bark, bottom furnace ash or both. Sewage sludge alone or with bark or ash dramatically improved loblolly pine seedling growth and grass biomass production in comparison to other soil treatments. Total seedling volume was 20 times greater and grass biomass was 5 times greater in sludge plots than nonsludge plots. In study three, 2 sweetgum genotypes were grown on plots amended with 0, 1/4", 1/2", or 1" of dried sewage sludge. On nonamended plots trees are less than 1 meter tall while on sludge-amended plots, trees are 2 to 4 meters tall.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 11366, 11372, 12625

12499 (DOE/DP/00269—37) **Amchitka Radiobiological Program. Progress report, January-December 1978.** Tornberg, L.D.; Nakatani, R.E. (Washington Univ., Seattle (USA). Lab. of Radiation Ecology). Jul 1979. Contract EY-76-S-08-0269. 62p. Dep. NTIS, PC A04/MF A01.

The Amchitka Radiobiological Program began in 1970 and is a continuing program to collect biological and environmental samples for radiometric analyses. This report is an account of the program for calendar year 1978. Results of analyses for samples collected in August 1978 have been added to the tables of Seymour and Johnson (1978) which summarize the Amchitka program from 1970 to 1977 and include analyses for: (1) gamma-emitting radionuclides in freshwater, birds, lichens, marine algae, marine invertebrates, fish, aufwuchs, and freshwater moss and plants; (2) strontium-90 (^{90}Sr) in rats, birds, and soil; (3) ^{239}, ^{240}Pu in sand, soil, marine algae, and fish; and (4) tritium (^{3}H) in seawater, freshwater, and biological organisms. Monitoring of background radiation with survey instruments was added to the Laboratory's program in 1974, and the results of the five annual surveys since that date are included in this report. Conclusions from the results of the recent analyses are a reiteration of the results stated in Nelson and Seymour (1975a); namely, (1) no new radionuclides are present; (2) the most abundant radionuclides are naturally occurring beryllium-7 (^{7}Be) and potassium-40 (^{40}K); (3) the trace quantities of fission products and induced radionuclides are from world fallout; and (4) a trace of ^{3}H contamination remains in some Long Shot ponds, as previously reported. It is concluded that there were no radionuclides of Milrow or Cannikin origin in the water, plants, or animals of Amchitka Island.

12500 (EGG—1183-1734) **Aerial radiological survey of the area surrounding the Joseph M. Farley Nuclear Plant, Dothan, Alabama, date of survey: March 1977.** Hilton, L.K. (EG and G, Inc., Las Vegas, NV (USA). Energy Measurements Group). Nov 1978. Contract EY-76-C-08-1183. 14p. Dep. NTIS, PC A02/MF A01.

An airborne radiological survey of a 2146 km^2 area surrounding the Joseph M. Farley Nuclear Plant was made 19-23 March 1977. Detected radioisotopes, and their associated gamma ray exposure rates, were consistent with that expected from the normal background emitters. Count rates observed at 152 m altitude are converted to equivalent exposure rates at 1 m above the ground, and are presented in the form of an isopleth map. Exposure rates measured with small portable instruments and soil sample analysis showed agreement with the airborne data.

12501 (EGG—1183-1739) **Aerial radiological survey of the United States Department of Energy's Battelle Nuclear Science Facility, West Jefferson, Ohio, date of survey: May 1977.** Feimster, E.L. (EG and G, Inc., Las Vegas, NV (USA). Energy Measurements Group). May 1979. Contract EY-76-C-08-1183. 13p. Dep. NTIS, PC A02/MF A01.

An aerial radiological survey to measure terrestrial gamma radiation was carried out over the United States Department of Energy's Battelle Nuclear Science Facility located in West Jefferson, Ohio. Gamma ray data were collected over a 5.5 km^2 area centered on the facility by flying east-west lines spaced 61 m apart. Processed data indicated that on-site radioactivity was primarily due to radionuclides currently being processed due to the hot lab operations. Offsite data showed the radioactivity to be due to naturally occurring background radiation consistent with variations due to geologic base terrain and land use of similar areas.

12502 (NUREG/CR—1125) **Population dose commitments due to radioactive releases from nuclear power plant sites in 1976.** Baker, D.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Dec 1979. Contract EY-76-C-06-1830. 113p. (PNL—2940). Dep. NTIS, PC A06/MF A01.

Population radiation dose commitments have been estimated from reported radionuclide releases from commercial power reactors operating during 1976. Fifty-year dose commitments from a one-year exposure were calculated from both liquid and atmospheric releases for four population groups - infant, child, teenager and adult - residing between 2 and 80 km from each site. Results are given in the form of tables giving the dose commitments for both liquid and airborne pathways for each age group and organ. Also included for each site is a histogram showing the fraction of the total population within the 2 to 80-km region around each site receiving various average dose commitments from the airborne pathways. The total dose commitment from both liquid and airborne pathways ranged from a high of 160 person-rem to a low of 0.0002 person-rem with an arithmetic mean of 11 person-rem. The total population dose for all sites was estimated at 470 person-rem for the 90 million people considered at risk.

12503 (PNL—2947) **Radiation characterization, and exposure rate measurements from cartridge, 105-mm, APFSDS-T, XM774.** Bartlett, W.T.; Gilchrist, R.L.; Endres, G.W.R.; Baer, J.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Nov 1979. Contract EY-76-C-06-1830. 87p. Dep. NTIS, PC A05/MF A01.

In response to a recommendation from the Joint Technical Coordinating Group for Munitions Effectiveness, Working Group on Depleted Uranium Munitions, the Department of the Army contracted with Pacific Northwest Laboratory (PNL) to investigate the health physics problems associated with the assembly, storage, and use of 105-mm, APFSDS-T, XM774 ammunition. Each round of this ammunition contains a penetrator rod of 3.4 kg of depleted uranium (DU), which is classified as a radioactive source material. The study carried out by PNL included laboratory and field analyses and an assessment of current health physics practices. The data sought included: the characteristics of radiation emitted from a penetrator and an assembled projectile; a comparison of film and thermoluminescent dosimeters; a comparison of radiation detection instruments; and the exposure rates from a single XM774 round, a loaded storage container, a standard pallet, and a loaded tank.

12504 **Natural and technologically enhanced sources of radon-222.** Travis, C.C.; Watson, A.P.; McDowell-Boyer, L.M.; Cotter, S.J.; Randolph, M.L.; Fields, D.E. (Oak Ridge National Lab., TN). *Nucl. Saf.:* **20**: No. 6, 722-728(Nov 1979).

An assessment of ^{222}Rn releases (curies/year) from major natural and technologically enhanced sources in the United States is presented. The resulting inhalation population dose commitments to the bronchial epithelium of the lung (lung-rem) are also estimated. The sources of radon considered are natural soil, evapotranspiration, potable water supplies, building materials, natural gas, uranium mining and milling, coal and phosphate mining, phosphate fertilizer, liquefied petroleum gas, geothermal power facilities, coal-fired power plants, and gas and oil wells. The most important natural source of ^{222}Rn is decay of ^{226}Ra in the soil and rocks of the earth's crust. This source results in approximately 40% of the total population dose from all sources of radon. The largest technoligcally enhanced contributor to population dose is airborne ^{222}Rn in building interiors, which is estimated to contribute 55% to the total population exposure to ^{222}Rn. Each of the other sources is estimated to contribute less than 3% to the total.

12505 **Statistical considerations and survey of plutonium concentration variability in some terrestrial ecosystem components.** White, G.C.; Hakonson, T.E. (Los Alamos Scientific Lab., NM). Contract W-7405-ENG-36. *J. Environ. Qual.;* **8**: No. 2, 176-182(Apr 1979).

Statistical aspects of the use of the coefficient of variation (c) in the design of environmental plutonium studies are considered. Small sample properties of the estimate of c were studied for both normal and log-normal populations with Monte Carlo simulations. A minimum sample size of 50 is necessary to estimate c with much precision, and an estimate of c from a sample size of less than 5 is nearly worthless. The difficulty of achieving good estimates of c increases as the true value of c increases. In addition, some of the available data on the variability of plutonium concentrations in terrestrial ecosystem components is summarized. The data were pooled to achieve better estimates of the coefficient of variation than might be available from individual studies. Pooled estimates of c are: soils, 1.35; vegetation, 0.70; and rodent tissues, 1.10. The estimates of c presented should be useful in designing a field sampling program for plutonium.

SOIL

REFER ALSO TO CITATION(S) 11345, 11354, 11364, 11369, 11370, 11371, 11373

12506 (CONF-781108—, pp 296-324) **Some statistical aspects of the cleanup of Enewetak Atoll.** Barnes, M.G.; Giacomini, J.J.; Friesen, H.N. (Desert Research Inst., Las Vegas, NV). Jul 1979.

From 4. DOE statistical symposium; Albuquerque, NM, USA (1 Nov 1978).

Cleaning up the radionuclide contamination at Enewetak Atoll has involved a number of statistical design problems. Theoretical considerations led to choosing a grid sampling pattern; practical problems sometimes lead to resampling on a finer grid. Other problems associated with using grids have been both physical and statistical. The standard sampling system is an in situ intrinsic gamma detector which measures americium concentration. The cleanup guidelines include plutonium concentration, so additional sampling of soil is required to establish Pu/Am ratios. The soil sampling design included both guidelines for location of the samples and also a special pattern of subsamples making up composite samples. The large variance of the soil, sample results makes comparison between the two types difficult anyway, but this is compounded by vegetation attenuation of the in situ readings, soil disturbance influences, and differences in devegetation methods. The constraints inherent in doing what amounts to a research and development project, on a limited budget of time and money, in a field engineering environment are also considered.

12507 (EGG—1183-1686) **Aerial radiological survey of US Department of Energy sites in Ames, Iowa. Date of survey: May 1977.** (EG and G Idaho, Inc., Idaho Falls (USA)). Jul 1979. Contract EY-76-C-08-1183. 14p. Dep. NTIS, PC A02/MF A01.

An aerial radiological survey to measure terrestrial gamma radiation was carried out over five areas totaling 10 km^2 within the town of Ames, Iowa. Gamma ray data were measured over Ames Laboratory, several sections of downtown Ames, and the surrounding area. This was accomplished by flying parallel east-west lines 61 m apart. Processed data indicated that three areas showed increased activity levels of at least twice average background: the reactor, the waste treatment area, and a small area near the airport runway.

12508 (EGG—1183-1721) **Aerial radiological survey of the area surrounding the Mallinckrodt Nuclear Maryland Heights Facility and two additional sites, St. Louis, Missouri. Date of survey: October 1977.** (EG and G Idaho, Inc., Idaho Falls (USA)). Sep 1979. Contract EY-76-C-08-1183. 22p. Dep. NTIS, PC A02/MF A01.

An aerial radiological survey to measure terrestrial gamma radiation was carried out over the Mallinckrodt Nuclear Maryland Heights Facility during October 1977. At the same time the following properties were also surveyed: a parcel near 9200 West Latty Avenue, which included a portion of St. Louis International Airport; and land used by West Lake Landfill, Inc., which is 8 km northwest of the airport. Gamma ray data were collected by flying parallel lines 60 m apart. The total area surveyed over the three sites was 7.4 km^2. Processed data indicated that detected radioisotopes and their associated gamma ray exposure rates were consistent with those expected from normal background emitters, except at certain locations described in this report. Average exposure rates 1 m above the ground, as calculated from aerial data, are presented in the form of an isopleth map. No ground sample data were taken at the time of the aerial survey.

12509 (EML—370, pp I.35-I.59) **Analyses of quality control samples at EML and contractor laboratories during 1979.** Hardy, E.P. 1 Jan 1980.

In Environmental Measurements Laboratory. Environmental quarterly, September 1 through December 1, 1979.

Sets of biological and fallout samples analyzed at EML and by contractor laboratories include quality control samples which are submitted as blinds. These checks consist of blanks, reference samples analyzed repeatedly over a period of years, replicates or splits of unknowns, spikes, and duplicate samplings. Quality control data for ashed bone, various ashed foods and vegetation, tap water, deposition samples and soil analyzed for Sr-90, Pu-239,240, Pu-238, Am-241 and Ca during 1979 are summarized.

12510 (NUREG/CR—1056) **Review of behavior of plutonium in soils and other geologic materials.** Nishita, H. (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology). Oct 1979. Contract EY-76-C-03-0012. 121p. (UCLA—12-1193). Dep. NTIS, PC A06/MF A01.

Available information on the physical and chemical reactions of Pu in soils and other geologic materials is reviewed. The primary intent of this review was to bring together information that may be helpful in assessing the movement and biological availability of Pu in terrestrial environment. The review is divided into two general categories, e.g., studies of chemical reactions of Pu in aqueous solutions and studies of Pu reactions in the more complex systems of soils and other geologic materials. The latter category is further divided into studies of Pu in materials that were freshly contaminated in the laboratory and of Pu in materials that had been contaminated in natural environments and had resided there for varying numbers of years. After the discussion of physical and chemical reactions of Pu, several reported examples of the actual movement of Pu in terrestrial environments are given.

12511 (ORNL—5450) **Radiological survey of the inactive uranium-mill tailings at Tuba City, Arizona.** Haywood, F.F.; Jones, T.D.; Hubbard, H.M. Jr.; Ellis, B.S.; Shinpaugh, W.H. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 79p. Dep. NTIS, PC A05/MF A01.

Results of a radiological survey of the inactive uranium-mill site at Tuba City, Arizona, conducted in March 1976, are presented. Spread of tailings was detected in all directions by means of direct gamma measurements at 1 m above the ground and by determinations of the ^{226}Ra concentration in surface soil and sediment samples. In the direction toward which prevailing winds blow, the northeast, evidence of transportation of tailings was found at least 3.2 km from the tailings pile. Toward the north, south, and west, the spread was 300 to 400 m. Evidence of movement of tailings by water to offsite locations was also found. The concentration of ^{226}Ra in all water samples was well below the concentration guide for drinking water. The calculated subsoil distribution of ^{226}Ra in 14 holes, based on gamma monitoring data obtained by Ford, Bacon and Davis Utah

Inc., is presented graphically and compared with available analytical data.

12512 Effect of fulvic and humic acids and inorganic phase of soil on the sorption and extractability of ^{239}Pu(IV). Nishita, H.; Haug, R.M. (Univ. of California, Los Angeles). *Soil Sci.;* **128**: No. 5, 291-296(Nov 1979).

The effect of organic (fulvic and humic acids) and inorganic fractions of soil on the sorption and extractability of ^{239}Pu(IV) as a function of pH was determined by using an equilibrium batch technique. The results indicated that Pu(IV) is strongly sorbed on the inorganic fraction of the soil under soil pH conditions normally encountered in natural environments. Plutonium appeared to form stable complexes or chelates with fulvic and humic acids in the pH range studied (1.3 to 11.7). In mixtures of pure fulvic or humic acids with soil inorganic fractions, extractability of Pu was substantially influenced by organic-inorganic interaction. The influence of the inorganic fractions was most evident in the lower pH ranges, whereas that of the organic materials was most evident in the higher pH ranges, generally above pH 6. Some implications of the results on plutonium movement in soils were discussed.

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 12509, 12599

12513 (EMSL-LV—0539-26) **Animal investigation program: Nevada test site and vicinity. Annual report, 1977.** Smith, D.D.; Crockett, A.B.; Bernhardt, D.E.; Giles, K.R.; Kinnison, R.R. (Environmental Protection Agency, Las Vegas, NV (USA). Environmental Monitoring and Support Lab.). Jul 1979. Contract EY-76-A-08-0539. 98p. Dep. NTIS, PC A05/MF A01.

Data are presented from the radioanalysis of tissues collected from cattle, mule deer, desert bighorn sheep, rabbits, feral horses, and other wildlife that resided on or near the Nevada Test Site. Routine activities and special investigations of the Animal Investigation Program are also discussed. Other than potassium-40, gamma-emitting radionuclides were detected infrequently. Strontium-90 concentrations in bones from deer, cattle, and desert bighorn sheep continued the downward trend of recent years. Tritium concentrations were generally within expected environmental limits with the exception of animals exposed to sources of contamination. Radionuclide tissue concentrations were generally higher in the tissues of animals residing in Area 15 than in other areas. Statistical analyses made of plutonium-239 levels reported in cattle tissue collected from 1971 through 1977 reveal that activity levels in lungs, liver, and bone are significantly related to age. Activity levels did not change significantly in the ingesta and lungs during this time but did tend to increase for bone and liver. Activity levels in the ingesta are significantly higher in the fall than in the spring. Hypothetical dose estimates to man were calculated on the basis of liver or muscle from animals that contained peak radionuclide levels. The highest postulated dose was 8.6 millirems for tritium in tissues from a mule deer. The movements of 17 mule deer were monitored on a weekly basis.During the winter months, all deer left their summer range on the mesas of the Nevada Test Site and migrated 40 to 60 kilometers south and west. A statistical estimate was made of the deer population in selected areas utilizing the marked deer as a basis for this estimate. No gross or microscopic lesions were found in necropsied animals that could be directly attributed to the effects of ionizing radiation.

12514 Deciduous: the changing face of eastern North America. Burgess, R.L. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Frontiers;* v(Spr 1978).

The author describes the forest vegetation and expanse in North America prior to the advent of European man. He describes the changing landscape of eastern North America which resulted because of agriculture, lumbering, industrialization, and urbanization. The forests have undergone extensive changes as well in 3 areas: (1) continued forest fragmentation, (2) regional or local extinction of species, and (3) the loss of virgin ecosystems that constitute baseline systems against which to assess and predict the environmental impact of man's varied activities. These changes are discussed.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 12535

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 11100, 11102, 11127, 11128, 11129, 11133, 11283, 11286, 11349, 11352, 11355, 11358, 11359, 11360, 11373, 12490, 12513

12515 (ANL/LRP—4) **Staunton 1 Reclamation Demonstration Project. Progress report II.** (Argonne National Lab., IL (USA)). Jul 1979. Contract W-31-109-ENG-38. 111p. Dep. NTIS, PC A06/MF A01.

The Staunton 1 Reclamation Demonstration Project involves an evaluation of the reclamation process on a 13.8-ha abandoned deep coal mine refuse site in southwestern Illinois. The procedure included collection of preconstruction environmental data, determination of the site's final land use, and development and implementation of a detailed site development plan. Approximately 9.3 ha of refuse material was recontoured, covered with a minimum of 30 cm of soil obtained on site, and seeded with a mixture of grasses and legumes. Hydrologic investigation indicates some improvement in groundwater quality. Surface water quality also has shown improvement, but development of the aquatic ecosystem in the newly-constructed pond is slow. Revegetation has been successful, and a protective plant cover has been established on most areas of the site. Soil tests indicate that acceptable plant growth media have been constructed; however, continued application of fertilizer and limestone will probably be necessary to maintain the vegetation. The soil microbial community has achieved total numbers equal to those of old fields, but species' diversity is low. Small mammals, birds, reptiles, and amphibians have invaded and are utilizing the site. The economic value of the site and adjacent property has increased substantially, and the area's aesthetic value has been enhanced significantly. The two-year period of intensive monitoring and evaluation has been utilized to develop recommendations for improving the designs of future reclamation efforts.

12516 (CONF-7910117—1) **Multidisciplinary approach to reclamation of abandoned refuse sites.** Zellmer, S.; Wilkey, M. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 13p. Dep. NTIS, PC A02/MF A01.

From Coal conference and EXPO V; Louisville, KY, USA (23 Oct 1979).

The Staunton 1 Reclamation Demonstration Project involves an evaluation of the reclamation process at an abandoned coal mine refuse site in southwestern Illinois. A multidisciplinary team of scientists and engineers selected the site, collected baseline environmental data, determined the final land use, and developed and implemented detailed engineering plans. Refuse material at the 34-acre site was recontoured and covered to a minimum depth of one foot with soil obtained on-site. This same multidisciplinary approach is being used to evaluate post-construction environmental conditions at the site. Current investigations are monitoring conditions related to groundwater, surface water, aquatic ecosystems, revegetation, soils, erosion and runoff, soil microbial populations, and wildlife invasion. Information collected to date indicates that a significant improvement has occurred in the environmental quality of the site. The economic potential of the site is also being investigated and documented; a substantial increase in the economic potential of the site and adjacent properties has been recorded. The project is demonstrating methods that can be used to reclaim abandoned coal refuse sites and is providing design for future reclamation efforts of this type.

12517 (DOE/SR/10018—1) **Site management plan: Douglas Point Ecological Laboratory.** Jensen, B.L.; Miles, K.J.; Strass, P.K.; McDonald, B. (Charles County Community Coll., La Plata, MD (USA). Div. of Biological Sciences). 17 Sep 1979. Contract AS09-79SR10018. 112p. Dep. NTIS, PC A06/MF A01.

A portion of the Douglas Point Site has been set aside for use as an ecological monitoring facility (DPEL). Plans call for it to provide for long-term scientific study and analysis of specific terrestrial and aquatic ecological systems representative of the coastal plain region of the mid-Atlantic United States. Discussion of the program is presented under the following section headings: goals and objectives; management and organization of DPEL; laboratory director; site manager; monitoring manager; research manager; and, organizational chart. The seven appendixes are entitled: detailed site description; supplemental land use plan; contract between Potomac Electric Power Company and Charles County Community Collge (CCCC); research and monitoring projects initiated at the Douglas Point Power Plant site; advisory committees; facilities and equipment; and CCCC personnel resumes. (JGB)

12518 (PB—292982) **Surface mining report for minerals other than coal, calendar year 1977.** (North Dakota State Soil Conservation Committee, Bismarck (USA)). 1977. 39p. NTIS PC A03/MF A01.

The North Dakota State Soil Conservation Committee was designated by the Legislature to administer the Surface Mining Reports Law, which requires any person conducting surface mining operations for minerals other than coal, to comply with the reporting requirements of Chapter 38-16 (North Dakota Century Code). This Law requires any person conducting surface mining operations for minerals other than coal, which within one calendar year, removes 10,000 cubic yards or more of earthen material or product, including overburden, or affects one-half acre or more in combined mining operations to report. Minerals included are: cement rock,

clay, gravel, limestone, manganese, molybdenum, peat, potash, pumicite, salt, sand, scoria, sodium sulfate, stone, zeolite, or other minerals, but does not include coal. The Surface Mining Report is a list of surface mining operators and their surface mining activities for calendar year 1977 and a list of surface mining operators not required to report for calendar year 1977. Also included is a list of those operators contacted but not conducting surface mining activities and those operators not responding.

12519 (SAND—80-7035) **Status of endangered and threatened plant species on Tonopah Test Range: a survey.** Rhoads, W.A.; Cochrane, S.A.; Williams, M.P. (Santa Barbara Research Center, Goleta, CA (USA)). Oct 1979. Contract EY-76-C-04-0789;EY-76-C-08-1183. 126p. Dep. NTIS, PC A07/MF A01.

Six species under consideration by the US Fish and Wildlife Service (FWS) for endangered or threatened status were found on or near the Tonopah Test Range (TTR) in southern central Nevada. Based on recognized threats to these species, their overall distribution, rarity, and other factors, status recommendations were prepared for Sandia Corporation. In addition, ten species that occur in the vicinity of TTR, and which may yet be found on TTR, are discussed in brief. Each species is discussed in relation to distribution, rarity, taxonomy, habitat requirements, endangerment, assessment of status, and proposed protection and monitoring needs. Construction activities and off-road vehicle travel are the most prominent man-caused threats to species on TTR; habitat destruction by trampling and over-grazing by feral horses and non-permit cattle significantly modifies habitats of certain species. We recommend two kinds of protective measures. First is the planning of activities so that habitats, particularly the suggested protected habitats, are not disturbed. Second, and directed to the same end, off-road traffic should be curtailed in the regions of the proposed protected habitats.

REGULATIONS

REFER ALSO TO CITATION(S) 12491, 12496

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 12493, 12494, 12495, 12698, 12699

12520 (DOE/EV/10005—1) **Coastal shelf transport and diffusion. Annual progress report, 1979.** Csanady, G.T. (Woods Hole Oceanographic Institution, MA (USA)). Nov 1979. Contract AC02-79EV10005. 19p. Dep. NTIS, PC A02/MF A01.

Research progress in studies on the physical properties of the coastal ocean relevant to energy related activities is reported. During the past contract year progress was made in the analysis of observations within the coastal boundary layer (0 to 12 km from shore off Long Island), in the measurement of shear flow just below the air-sea interface and in the understanding of the dynamics of continental shelf circulation. A model of nearshore tidal currents has been constructed and related to observation, resulting in a quantification of frictional effects. A new method was developed for observing the velocity distribution near a free surface. Long-term shelf circulation was found to be governed by two types of pressure field, a trapped field related to topography, and an outer field impressed on the shelf by large-scale oceanic gyres.

12521 (EDFB/IBP—77/6) **Analysis of nonlinear matrix equations for fish population dynamics.** Svoboda, L.J.; DeAngelis, D.L. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 84p. Dep. NTIS, PC A05/MF A01.

Thesis. Submitted by L.J. Svoboda to Univ. of Tennessee, Knoxville.

P.H. Leslie's matrix model, which predicts population size of individual age classes in discrete time intervals, is examined. Leslie's original constant matrix, as well as the more general nonconstant matrix, to which density-dependence (compensation) has been added, are discussed. The properties of the matrix itself and the properties of the modeled population are presented for each type of model. A population is modeled with the probability of survival of the 0/sup th/ age class, p_0, assumed to be density dependent. The stability of this population, i.e., ability to maintain steady-state, is predicted. It is shown that a population modeled with p_0 depending only on the population size of age class 0 will always be stable. When p_0 depends on the populations of older age classes it is possible for the population to be unstable, depending on the specific functional relationship.

12522 (ORO—5572-2) **Fate of chlorine in seawater. Progress report, October 1, 1978-October 31, 1979.** Wong, G.T.F. (Old Dominion Univ., Norfolk, VA (USA). Dept. of Oceanography). Nov 1979. Contract EE-77-S-05-5572. 52p. Dep. NTIS, PC A04/MF A01.

Investigations on the effects of the concentration of bromide ion, temperature and sunlight on the rate of consumption of chlorine in seawater were performed. In addition, the analytical chemistry of residual chlorine in seawater, the effect of organic compounds in seawater in various molecular weight size fractions, and the effect of ammonia on the rate of consumption of chlorine in seawater were studied.

12523 **Estimating and predicting changes in wetland water levels.** Terrell, R.E.; Andrews, C.B.; Bedford, B.L.; Loucks, O.L. (Univ. of Wisconsin, Madison). pp 167-169 of Fourth joint conference on sensing of environmental pollutants. Washington, DC; American Chemical Society (1978).

From 4. joint conference on sensing of environmental pollutants; New Orleans, LA, USA (6 Nov 1977).

The water regime and vegetation of an extensive sedge meadow/shallow marsh area in the Wisconsin River floodplain has been studied since 1971. In 1974 a two square kilometer (490 acre) cooling lake for a 527 MWe fossil-fueled electric generating station was constructed in this area. Leakage from this impoundment has altered the groundwater flow patterns in the area. Groundwater influx (the primary water source of the wetland) to the remaining wetland has increased considerably. This has had a marked effect on the vegetation in the wetland. An attempt was made to model the water level changes in this wetland. The goal is to develop a predictive capability to estimate anticipated water level changes at other sites with similar perturbations proposed or under construction. By combining this information with knowledge of the existing wetland vegetation, the proposed construction could be modified or positioned so as to minimize the expected changes in the structure and function of the wetland.

RADIOMETRIC TECHNIQUES

REFER ALSO TO CITATION(S) 12532

12524 (EGG—1183-1750) **Water equivalent of snow survey of the Red River Basin and Heart/Cannonball River Basin, March 1978.** Feimster, E.L. (EG and G, Inc., San Ramon, CA (USA). Energy Measurements Group). Oct 1979. Contract EY-76-C-08-1183. 17p. Dep. NTIS, PC A02/MF A01.

The water equivalent of accumulated snow was estimated in the Red River and Heart/Cannonball River basins and surrounding areas in North Dakota during the period 8 to 17 March 1978. A total of 570 km were flown, covering a 274 km section of the Red River Basin watershed. These lines had been surveyed in March 1974. Twelve flight lines were flown over the North Dakota side of the Red River from a point 23 km south of the Canadian border southward to the city of Fargo, North Dakota. The eight flight lines flown over the Minnesota side of the Red River extended from 23 km south of the Canadian border southward to Breckenridge, Minnesota. Using six flight lines, a total of 120 km were flown in the Heart/Cannonball River Basin, an area southwest of the city of Bismark, North Dakota. This was the first such flight in the Heart/Cannonball River Basin area. Computed weighted average water equivalents on each flight line in the Red River Basin ranged from 4.8 cm to 12.7 cm of water, averaging 7.6 cm for all lines. In the Heart/Cannonball River Basin, the weighted water equivalent ranged from 8.9 cm to 19.1 cm of water, averaging 12.7 cm for all lines. The method used employs the measurement of the natural gamma rays both before and after snow covers the ground.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 11124, 11129, 11131, 11132, 11231, 11233, 11422, 11997, 12456, 12533, 12539, 12669

12525 (AD-A—065830) **Development of an enzymic electrode oil in water sensor. Final report 1 March-31 December 1978.** Cundell, A.M.; Patni, N.J.; Findl, E. (BioResearch, Inc., Farmingdale, NY (USA)). 31 Jan 1979. Contract N00014-78-C-0230. 29p. NTIS, PC A03/MF A01.

Environmental criteria for coastal waterways have been established limiting the maximum concentration of oil in ship overboard discharge streams to 100 ppm of oil. Ongoing research at various Navy and Coast Guard facilities has indicated that there are inadequacies in presently available chemical analysis instrumentation needed to monitor discharge streams aboard sea-going vessels. These inadequacies primarily center on interference problems, maintenance problems, operational complexity and high cost. As a result, an in-house program was initiated, with corporate funding. This program

resulted in a novel device concept which can, with suitable development, provide the Navy and Coast Guard with an instrument for oil-in-water detection that will eliminate all of the inadequacies previously noted. The concept is the use of a hydrocarbon oxygenase enzyme electrode.

12526 (ANL/LRP-TM—15) **Characterization of three acid strip mine lakes in Grundy County, Illinois.** Master, W.A. (Argonne National Lab., IL (USA)). Sep 1979. Contract W-31-109-ENG-38. 69p. Dep. NTIS, PC A04/MF A01.

Three small lakes with acid water and one with circumneutral water at an abandoned strip mine site were characterized to identify factors limiting biological productivity. Dissolved oxygen, specific conductance, and temperature profiles were determined. Water samples were analyzed for 23 parameters, and the lakes were examined for the presence of aquatic vascular plants and benthic inhabitants. The acid lakes ranged from 0.9 ha to 2.7 ha in surface area and from 3.1 m to 6.7 m in maximum depth. The mean pH of the acid lakes ranged from 3.1 to 3.9. Chemicals found at concentrations higher than Illinois surface water standards or federal criteria for the protection of aquatic life included Cd, Cu, Fe, Mn, SO_4=, and Zn. A number of these chemicals were at sufficiently high concentrations to limit the survival and productivity of most aquatic fauna. The lake with the poorest water quality had the least diversity of aquatic vascular plants and benthic invertebrates, while the circumneutral lake had the greatest diversity of species.

12527 (NTIS/PS—79/0687) **Water quality modeling - hydrological and limnological systems. Volume 3. July, 1977-June, 1979 (a bibliography with abstracts). Report for Jul 1977-Jun 1979.** Carrigan, B. (National Technical Information Service, Springfield, VA (USA)). Jul 1979. 208p. NTIS PCN01/MF N01.

The abstracts contain information on models used to describe water quality, including models of the chemical, physical, biological, and hydrological processes important to water quality. Studies are included on th modeling of eutrophication, nutrient removal, pollutant dispersion, stream flow, heat dissipation, limnological factors, aquifer water quality, and water runoff quality. (This updated bibliography contains 200 abstracts, 114 of which are new entries to the previous edition.)

12528 (PB—290968) **Determination of zinc, cadmium, lead, and copper in water by anodic stripping voltammetry.** Howe, L.H.; Jones, I.E. (Tennessee Valley Authority, Chattanooga (USA). Div. of Environmental Planning). May 1978. 50p. NTIS, PC A03/MF A01.

The Tennessee Valley Authority developed a method of differential pulse anodic stripping voltammetry for determining total concentrations of cadmium and lead in water samples from ash ponds at steam-electric generating plants. After digestion of the sample and addition of reagents to overcome interferences by iron (III) and selenium (IV), the peak current for cadmium and lead is measured and quantified by standard addition. The effective range for this method is 0.3 to 100 microgram/l of cadmium and 3 to 100 microgram/l of lead. This method gives suitable accuracy for cadmium and lead in reference water samples and in split samples of effluent water from ash ponds that were analyzed by atomic absorption. Limited data show that this method probably also can be used for 5 to 100 microgram/l copper but that it is unsuitable for zinc because of a 15-microgram/l sample blank.

12529 (PB—294211) **Inductively coupled plasma-atomic emission spectroscopy: prominent lines. Final report March 1977-February 1978.** Winge, R.K.; Peterson, V.J.; Fassel, V.A. (Ames Lab., IA (USA)). Mar 1979. 72p. NTIS, PC A04/MF A01.

Nearly every phase of environmental protection depends on a capability to identify and measure specific pollutants in the environment. As part of the research on the occurrence, movement, transformation, impact, and control of environmental contaminants, new techniques for identifying and measuring chemical constituents of water and soil have been developed. The use of inductively coupled plasma (ICP)-atomic emission spectroscopy is expected to increase rapidly as analytical chemists confront new problems in elemental characterization. This report records the prominent lines of the ICP emission spectra of some 70 elements as the first step in the development of a spectral atlas that would serve as a useful tool in the selection of analytical lines for this spectroscopic technique.

12530 (PNL—3168) **Evaluation of an in-situ x-ray fluorescence analyzer for inorganic pollutants in sediments and water columns.** Wogman, N.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Sep 1979. Contract EY-76-C-06-1830. 61p. Dep. NTIS, PC A04/MF A01.

The applicability of an energy dispersive x-ray fluorescence spectrometer for measurement of trace elements in sediments and in water columns from Coast Guard vessels has been investigated. This investigation was conducted in both freshwater and saltwater areas and included Puget Sound, Lake Washington, Lake Union, and the ship canal in the State of Washington. The spectrometer system consisted of a solid cryogen-cooled Si(Li) detector and a ^{109}Cd excitation source. Sediments and water columns were viewed through a 0.2 mm Be window. This study showed the feasibility of measuring trace elements at concentrations ranging from 20 to about 100 ppM. Measurements of this sensitivity with a 100 mCi ^{109}Cd source are possible for time intervals as short as 5 minutes. This in-situ measurement capability permits the on-site mapping of pollution and avoids the problem of sediment disturbance which is inherent in the collection of grab samples of the sediment surface. Recommendations for an improved analyzer system included a detector assembly which could be towed, or allow continuous sediment surface analysis thereby recording the average composition of a large area.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 11372, 12502, 12504

12531 **Geologic migration potentials of technium-99 and neptunium-237.** Bondietti, E.A.; Francis, C.W. (Oak Ridge National Lab., TN). *Science;* **203**: 1337-1340(30 Mar 1979).

Relatively mobile TcO_4^- and NpO_2^+ can be chemically reduced to less soluble oxidation states in the presence of igneous rocks, as predicted by oxidation-reduction measurements. Current risk assessments, which consider technetium and neptunium as potentially capable of migrating from high-level radioactive waste repositories, may be overestimating their potential hazard to the public since the Fe(II) content of many subsurface waters may maintain these elements in less soluble oxidation states.

WATER

REFER ALSO TO CITATION(S) 11364, 11368, 11374

12532 (DOE/EV/10010—1) **Historical ^{14}C measurement from the Atlantic, Pacific, and Indian Oceans. Progress report, December 1, 1978-August 31, 1979.** Fairhall, A.W. (Washington Univ., Seattle (USA). Dept. of Chemistry). 1979. Contract EY-76-S-06-2225. 7p. Dep. NTIS, PC A02/MF A01.

Between the years 1964 and 1974, over 1000 sea water samples were collected from various locations and depths to 4000 M. These samples were processed to recover inorganic carbon (as CO_2) for laboratory measurement of ^{14}C. Aliquots of sea water, poisoned with mercuric chloride, were collected at the same time for total CO_2 measurement. During laboratory workup approximately 1/2 of the samples had small aliquots of CO_2 set aside for $^{13}C/^{12}C$ isotope ratio measurement. The purpose of the present project is to finalize all of this information along with the hydrographic data for each station.

AQUATIC ECOSYSTEMS AND FOOD CHAINS

12533 (DOE/EV/70024—31) **Chemical and geochemical studies off the coast of Washington. Progress report, September 1978-August 1979.** Carpenter, R. (comp.). (Washington Univ., Seattle (USA). Dept. of Oceanography). Aug 1979. Contract EY-76-S-06-2225-024. 11p. (RLO—2225-T24-31). Dep. NTIS, PC A02/MF A01.

Progress on a series of marine chemical and geochemical investigations involving both laboratory studies and field studies off the coast of Washington are summarized. Most of the field work has been on the Washington continental shelf, slope, and the submarine canyons indenting the shelf north of the Columbia River. The aim is to provide basic data required to characterize underlying chemical and physical processes and their rates which control the distributions, concentrations, and ultimate fate of some of the potentially hazardous agents associated with fossil fuel and nuclear power production or transportation. The studies have followed several main lines of investigation which are in various stages of completion: (1) field studies of the uptake and transport by zooplankton fecal pellets of ^{210}Po, ^{210}Pb, and other trace inorganic and organic constituents in a well-studied part of Puget Sound; (2) studies of the behavior of ^{210}Po and ^{210}Pb in sediments off the coast of Washington and the application of the ^{210}Pb determinations in sediment cores to determine sediment accumulation rates for the past 100 years, the depth of the surface mixed layer, and a mixing coefficient for the surface sediments; and (3) investigations of aliphatic and aromatic hydrocarbons in some of the same samples of organisms and sediment cores whose accumulation histories for the past 100 years we have determined with the ^{210}Pb technique.

12534 **Seasonal cycling of cesium-137 in a reservoir.** Alberts, J.J. (Savannah River Ecology Lab., Aiken, SC); Tilly, L.J.; Vigerstad, T.J. *Science;* **203**: 649-651(16 Feb 1979).

Studies of reservoir in the southeastern United States show that cesium-137, introduced into the system from a leak in a nuclear fuel element, cycles between the water and sediment on a seasonal basis. This cycling, which coincides with the annual periods of

thermal stratification in this monomictic lake, has been occurring for over 10 years.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 11911, 12527, 12639

12535 Alterations in the growth and phenology of wetland plants as indicators of environmental change. Bedford, B.L. (Univ. of Wisconsin, Madison). pp 170-174 of Fourth joint conference on sensing of environmental pollutants. Washington, DC; American Chemical Society (1978).

From 4. joint conference on sensing of environmental pollutants; New Orleans, LA, USA (6 Nov 1977).

Vegetation changes occurring in a wetland subject to thermal leakage from the cooling lake of a coal-fired power plant were studied for four years. It was hypothesized that the principal effects on wetland plants would occur from seasonal displacement of normal water temperatures. Quadrat counts and measures of associated environmental parameters were used to describe changes in community characteristics. Monthly measures of shoot numbers and height for Typha lafolia and Carex lacustris, as well as quarterly analysis of below-ground storage organs for total nonstructural carbohydrate, were used to ascertain the physiological mechanisms and associated field responses regulating change at the species level. Significant alterations in shoot emergence patterns and extensive plant mortality occurred within one year of station operation. Rapid invasion of newly opened habitat by annuals and the spread of tolerant, more hydrophytic perennial species followed. Generally, altered growth and phenology of dominant perennial species signaled significant change in plant population numbers. Extensive chlorosis in species which rely on over-wintering of fall-emerging shoots is an indicator of decreasing numbers. Early spring emergence and delayed dieback of spring emerging shoots suggest increasing numbers. The present study was undertaken to monitor the environmental change associated with leakage from the cooling lake of a coal-fired power plant, and establish ecologically-based criteria by which significant impact in a freshwater wetland could be recognized, monitored, and if possible, predicted. Meeting these objectives required identifying the stages in the depletions of some plant species and their replacement by others. Documenting the steps and the sequence by which changes in vegetation occur produces an outline of various stages.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 11276, 11283, 11368, 11999

12536 (PB—290481) **Environmental quality file 1972-1976, Winnebago County, Illinois. Final report.** Reilly, P.C. (Natural Land Inst., Rockford, IL (USA)). Aug 1978. 110p. NTIS, PC A06/MF A01.

Since Earth Day on April 22, 1970, there has been considerable coverage in the news media concerning the quality of the environment. But most of that coverage deals with national impacts while local environmental issues largely go unreported. This Environmental Quality Profile is an attempt to communicate to the citizens of Winnebago County the state of their environment.

12537 (PB—293567) **The coastal zone management act: requirements for the management of energy facilities in the coastal zone, volume II.** (Florida Div. of State Planning, Tallahassee (USA)). 28 Feb 1978. 298p. NTIS, PC A13/MF A01.

Partial contents: Identification and analysis of procedures currently implemented and recommendations for new methods for assessing the suitability of energy sites; Inter-agency and intergovernmental coordination process relative to energy facility siting; State policies for the management of energy facilities and their impacts; Analysis of state laws affecting energy facility site suitability assessment; Court decision in General Development Corporation vs. Division of State Planning; Additional provisions of the code of federal regulations regarding management of land and water uses in the coastal zone.

REGULATIONS

REFER ALSO TO CITATION(S) 11131, 12491, 12496, 12542

12538 (PB—295534) **A report on the University of Rhode Island's sea grant program, July 1977 to June 1978. Annual report.** Keiffer, E. (Rhode Island Univ., Narragansett (USA). Sea Grant Program). 1978. 22p. NTIS, PC A02/MF A01.

This annual report summarizes the Sea Grant Program at the University of Rhode Island from July 1977 to June 1978. Information is given on the advisory services, education, ongoing research programs, research completed in 1978, program development, project status fiscal year 1978, the activity budget and a list of Sea Grant publications and papers published during this period.

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

12539 (LA—8126-MS) **Survey of energy projects and instream resources in the upper Colorado and upper Missouri river basins.** Abbey, D.; Olinger, C. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 24p. Dep. NTIS, PC A02/MF A01.

Western energy production is certain to affect fisheries, recreation, aesthetic values, and water quality. Specification of these effects requires analysis of individual stream reaches. This report directs energy-related assessments to the most valuable and critical stream reaches. Section I identifies reaches in the Rocky Mountain/Northern Great Plains Region with high quality instream resources and energy projects in the vicinity or upstream from those reaches. Part A of Section II reviews methodologies for assessing streamflow modifications; Part B reviews legal aspects of streamflow protection - state water law and federal environmental legislation. The final section draws limited conclusions concerning the impacts of and constraints on energy development.

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 11138, 11283, 11994, 12049, 12423, 12606, 12610, 12688

12540 (CONF-790897—1) **Cultural resources and tradition: the consequences of their evaluation for socioeconomic impact assessment.** Curtis, S.A. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 27p. Dep. NTIS, PC A03/MF A01.

From Annual American Sociological Association meeting; Boston, MA, USA (27 Aug 1979).

The use of cultural resource data to improve the content and quality of the standard Environmental Impact Statement (EIS) socioeconomic profile and impact sections is illustrated. Emphasis is placed on an approach for identifying some kinds of potentially disruptive sociocultural changes in rural communities and ethnic groups that may be brought about by energy developments. The report is divided into three parts. Part one reviews the legislative reason for the EIS and problems with the current implementation of many socioeconomic studies. Part two explores how and why cultural resource data can be made meaningful for the EIS community studies and provides two case examples. Part three presents information for those who are not experts in cultural-resource management for quality control of usable culturalresource information.

12541 (KFK—2705) **Consequences of large-scale implementation of nuclear energy in the Federal Republic of Germany. Pt. 5. Public acceptance of nuclear energy.** Frederichs, G.; Loeben, M. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Abt. fuer Angewandte Systemanalyse). Feb 1979. 54p. (In German). (ASA/ZE—14/78). Dep. NTIS (US Sales Only), PC A04/MF A01.

The opposition to nuclear energy by significant parts of the population can be explained by a number of different and interdependent factors: psychological factors, communication and information problems, and different value orientations. The relevant approaches attributing the opposition to nuclear energy to such factors are described, followed by a more detailed analysis of social-structural developments in order to assess the political potential of the opposition movement. The analysis suggests that even in future the opposition to nuclear energy will remain a force which has to be reckoned with in politics.

12542 (PB—290916) **The economic impact analysis of effluent standards for total dissolved solids.** Huff, L.L. (Illinois Inst. of Natural Resources, Chicago (USA)). Oct 1978. 94p. NTIS, PC A05/MF A01.

The Illinois Effluent Standards Advisory Group has recommended elimination of the present total dissolved solids (TDS) effluent standard in Illinois. Presently the effluent standard prohibits an increase of more than 750 mg/l above the background concentration, except where resulting from waste treatment or recycle. In these two instances, a maximum of 3500 mg/l TDS would be permitted. The elimination of this standard would benefit potable water treatment plants, electric generating stations, and industrial discharger. Reduction of analytical costs and elimination of potential

treatment expenses are regarded as benefits of the proposed change. Environmental impacts are considered the costs incurred. Water users continue to pay additional expenses for operation because of the total dissolved solids concentration in streams. The effects upon each group of adopting the proposed change is summarized herein.

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 11409, 11411, 11924, 12444, 12485, 12486, 12670

12543 (DOE/EIS—0061-D) **Draft environmental impact statement: energy performance standards for new buildings.** (Department of Energy, Washington, DC (USA)). Nov 1979. 233p. W.H. Pennington, Office of NEPA, Washington, DC.

Proposed is the establishment of energy performance standards for new buildings, which are mandated by Congress in Section 304 of the Energy Conservation Standards for New Buildings Act of 1976 (adopted as Title III of the Energy Conservation and Production Act, P.L. 94-385, 42 U.S.C. 6801 et seq). The proposed standards, designed to achieve the maximum practicable improvements in energy efficiency and increases in the use of renewable sources of energy, are comprised of two fundamental elements: maximum levels of allowable annual energy requirements for space conditioning, domestic hot water and other specified energy uses for buildings, based on their designs, taking into account climate variations, the functional purpose(s) of the buildings, and the relative costs associated with using various forms of nonrenewable energy resources; and a method for calculating the annual energy requirements for buildings, based on building design and location, for use in determining compliance of the building design with the maximum allowable energy requirement levels provided in the standards. Environmental impacts analyzed in the EIS include pollutant releases from various building material production processes; pollutant releases resulting from the use of various energy forms; and indoor air quality concerns. The range of alternatives considered for the program include prescriptive standards rather than performance standards; energy pricing strategies; public education and information dissemination; and standards either more or less stringent than those actually proposed.

12544 (PB—293565) **Conventional combustion environmental assessment program, executive briefing. Report for October-November 1978.** Lattimore, P.K. (Northrop Services, Inc., Research Triangle Park, NC (USA)). Jan 1979. 20p. NTIS, PC A02/MF A01.

The brochure gives an executive briefing of EPA's Conventional Combustion Environmental Assessment (CCEA) Program. The CCEA Program was established recently to coordinate and integrate EPA's research and development efforts for assessing the environmental effects of pollutants from the conventional combustion of fossil fuels. The brochure highlights the purpose, scope, benefit, and results of the CCEA Program. It emphasizes CCEA methodology developed to provide a systematic approach for compiling information and data describing the effects of combustion-related emissions, and for comparison of their effects with identified environmental goals and objectives. It also describes the CCEA Program matrix for consolidating information on ongoing CCEA-related research, CCEA research and development efforts that have been incorporated into the program, and information transfer plans.

12545 (PB—294414) **Impact of industrial development on the quality of the environment.** Diamant, B.Z. (Nigerian Society of Agricultural Engineers, Zaria). Aug 1978. 18p. NTIS, PC A02/MF A01.

This document is a report presented to the second annual conference of the Nigerian Society of Agricultural Engineers, in Zaria, August 28-31, 1978. The purpose of this paper is to point out the mutual relationship that exists between industry and health, and the careful attention that has to be given to the health aspects while planning an industrialization program. The factors discussed in the paper are: water, air pollution, solid waste, town planning, vector control, housing, and industrial hygiene.

12546 (SERI/RR—352-357) **Market for ethanol feed joint products.** Hertzmark, D.; Gould, B. (Solar Energy Research Inst., Golden, CO (USA)). Oct 1979. Contract EG-77-C-01-4042. 82p. Dep. NTIS, PC A05/MF A01.

This report presents results of econometric estimations and mathematical simulations of markets for joint feed products of motor ethanol. The major issues considered are the nature of current market price relationships, effects on prices, including feed substitutes prices, and effects of demands for increased use of distillers' grains and gluten meal. The econometric section shows that soybean meal was by far the dominant force in the pricing of the two products. However, neither one could be adequately explained without the inclusion of corn in the estimating equations. Later research shows that this was due to the importance of both feeds for metabolizable energy as well as for protein in livestock diets. Current ration formulations would require some discounting of the value of the protein content of the two feeds. Careful siting of the ethanol facilities, and flexible design of the plants so that a maximum number of products may be extracted from the feedstock, seem necessary. Finally, the analysis indicates that substitution in animal diets of these joint products for the corn or milo used originally requires that additional energy be supplied to the animal by some type of forage crop. This implies that additional land may be required for energy production, for such marginal crops as hay and alfalfa, rather than for row crops.

ENVIRONMENTAL IMPACT STATEMENTS

REFER ALSO TO CITATION(S) 11125, 11126, 11239, 11240, 11241, 11242

12547 (DOE/EIS—0018) **Final environmental impact statement. Los Alamos Scientific Laboratory Site, Los Alamos, New Mexico.** (Department of Energy, Washington, DC (USA)). Dec 1979. 627p. Dep. NTIS, PC A99/MF A01.

The statement assesses the potential cumulative environmental impacts associated with current, known future, and continuing activities at the Los Alamos Scientific Laboratory (LASL) site. This includes the adverse impacts from postulated accidents associated with the activities. Various effluents including radioactive ones are released to the environment. However, a continuing, comprehensive, monitoring program is carried out to assist in the control of hazardous effluents. Alternatives considered to current operation of LASL include: cessation or relocation of programs; continue activities as presently constituted; further limitation of adverse impacts by institutional or other improvements in various operations; and expansion of current activities.

12548 (PB—290524) **Environmetal radiation protection requirements for normal operations of activities in the uranium fuel cycle (40 CFR 190). Volume I. Final environmental statement report.** (Environmental Protection Agency, Washington, DC (USA). Office of Radiation Programs). 1 Nov 1976. 240p. NTIS, PC A11/MF A01.

Volume I describes and evaluates new standards to limit radiation doses to the general public and quantities of long-lived radioactive materials in the general environment attributable to planned releases from operations contributing to the generation of electrical power through the uranium fuel cycle. These standards apply to milling, chemical conversion, isotopic enrichment, fuel fabrication, light-water-cooled reactors, and fuel reprocessing, but exclude mining, the transportation of radioactive materials in connection with any of these operations, and waste management operations. The standards specifically limit irreversible contamination due to releases of radioactive krypton, iodine 129, and alpha-emitting transuranics. The total reduction in potential health impact attributable to operations through the year 2000 is estimated to be in excess of 1000 cases of cancer, leukemia, and serious genetic effects in human populations. In addition maximum annual radiation doses are limited to 25 millirems to the whole body and all other organs except the thyroid, which would be limited to 75 millirems.

12549 (PB—290525) **Environmental radiation protection requirements for normal operations of activities in the uranium fuel cycle (40 CFR 190). Volume II. Final environmental statement report.** (Environmental Protection Agency, Washington, DC (USA). Office of Radiation Programs). 1 Nov 1976. 311p. NTIS, PC A14/MF A01.

Volume II provides responses to all comment letters submitted on the Draft Environmental Statement. Testimony, both written and oral, received in connection with the public hearing on the standards held March 8-10, 1976, and letters related to that hearing are not included. All of the comment letters are reproduced in the appendix together with an index which provides a guide to locating the comment letters by code number. The comments are grouped by subject matter into several areas of concern, which generally correspond to the organization of material in Volume I. The responses are brief, and make reference to Volume I and its supporting document when more detailed technical information is appropriate. Regulations setting forth these environmental radiation standards were promulgated in final form January 13, 1977 (42FR 2858).

BIOMEDICAL SCIENCES, BASIC STUDIES

BEHAVIORAL BIOLOGY

REFER ALSO TO CITATION(S) 12513, 12521, 12655, 12683

12550 (UCRL-Trans—11522) **(A) Parapsychology, (B) In favor of a scientific approach to parapsychology, (C) Psychokinetic experiments with metal test samples.** Roux, A.; Crussard, C.; Bouvaist, J. Translated from *Jaune et la Rouge;* No. 342, 3, 5, 13-23(Jun 1979). 44p. Dep. NTIS, PC A03/MF A01.

Eight experiments particularly well monitored involving the deformation of metal samples by an alleged psychokinetic agent are described. The subject, in separate tests, caused bends to appear in metal rods, magnetic properties of steel to change, and the surface hardness of metal disks to increase. These results were achieved without any apparent physical action on the part of the subject. (ACR)

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 12219, 12239, 12248, 12497, 12569, 12585, 12586, 12640, 12678

12551 (COO—5141-1) **Improvement of yields and rates during enzymatic hydrolysis of cellulose to glucose. Progress report, December 1, 1978-February 28, 1979.** Sundstrom, D.W.; Klei, H.E.; Coughlin, R.W. (Connecticut Univ., Storrs (USA). Dept. of Chemical Engineering). Mar 1979. Contract ET-79-S-02-5141. 14p. Dep. NTIS, PC A02/MF A01.

Emphasis during this quarter has been on the production of β glucosidase (β-G) from a microbial source and the immobilization of the β glucosidase on suitable supports. β-G has been grown and isolated from Aspergillis phoenicis. The crude enzyme powder was used satisfactorily during later immobilization studies. The β-G was immobilized on Corning alumina by adsorption with activity retention yields above 40%. Preliminary data on the half life of this support show negligible loss of activity in a fluidized bed after 200 hours when operating on a cellobiose substrate.

12552 (LBL—9746) **Electron paramagnetic resonance saturation studies of $P700^+$ reaction center chlorophyll in plant photosynthesis.** Rose, K.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 113p. Dep. NTIS, PC A06/MF A01.

Thesis.

Electron paramagnetic resonance (EPR) power saturation and saturation recovery methods have been used to determine the spin-lattice, T_1 and spin-spin, T_2, relaxation times of $P700^+$ chlorophyll in photosystem I reaction centers of plant chloroplasts as a function of temperature. T_1 varied between 9×10^{-4} seconds at 10°K and 2×10^{-4} seconds at 80°K. T_2 varied between 1.2×10^{-7} seconds at 7°K and 4×10^{-8} seconds at 40°K, corresponding to spin packet linewidths of 0.05 and 0.15 mT respectively. Incubation of D144 fragments with 10 mM ascorbate did not affect $P700^+$ spin-lattice relaxation. Ferricyanide was used to poise broken chloroplasts at a redox potential of 460 mV. Upon illumination at 40°K these samples exhibited a free radical signal which had a spin-lattice relaxation time of 8×10^{-5} seconds. The short relaxation time is caused by the presence of the ferricyanide. The spin-spin interaction between $P700^+$ and both iron sulfur center A and plastocyanin was also examined. Neither reduced center A nor oxidized plastocyanin exhibited any effect on $P700^+$ relaxation times. It was calculated that the minimum separation distance for the P700-center A pair and separation for the P700-plastocyanin pair is $\geq$ 30 A. A nonsaturating power level for the $P700^+$ signal at 25°K was determined by plotting a power saturation curve. A ratio of 4.8 +- 0.4 was achieved. This indicates that a spin state above the spin = 1/2 state of center A may be significantly populated at low temperature. If so, the entire EPR signal of center A may not be observable under the present conditions and the P700 to center A ration may be lower than measured here. Considering all of the above, the earlier model of a direct 1:1 relationship between P700 and center A can no longer be supported. A more satisfying model would include electron carriers A_1, A_2, and center B. (ERB)

12553 (LBL—10119) **Studies of chromatin in situ by fluorescence correlation spectroscopy.** Sorscher, S.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 195p. Dep. NTIS, PC A09/MF A01.

Thesis.

All systems in thermodynamic equilibrium are subject to spontaneous fluctuations from equilibrium. For very small systems, the fluctuations become apparent, and can be used to study the behavior of the system without introducing any external perturbations. The fluorescent dye Ethidium Bromide is especially useful as a probe of DNA because the changes in the fluorescence properties of the dye upon binding to DNA greatly enhance the effect of spontaneous fluctuations in the binding equilibrium. This sensitivity makes small regions of individual cell nuclei appropriate objects for study. All the measurements described employ a laser beam focussed to dimensions of the order of one micron. Knowledge of the beam radius is critical, and a new method for its determination in situ is reported. Experiments are described employing well characterized DNA preparations, including calf thymus DNA, SV-40 DNA, and calf thymus nucleohistone particles. Measurements made in small regions of isolated cell nuclei and on nuclei in vivo are described. These data indicate that the strength of dye binding increases in nuclei when the cells have been stimulated to enter the cell growth cycle. It is also shown that the viscosity decreases as the cells leave the resting state, and enter the cell growth cycle. These experiments demonstrate that fluorescence correlation spectroscopy can provide information at the subnuclear level that is otherwise unavailable. (ERB)

12554 **Conformation of the neurotoxin crotoxin complex and its subunits.** Hanley, M.R. (Univ. of California, Berkeley). Contract W-7405-ENG-48. *Biochemistry;* **18**: No. 9, 1681-1688(1 May 1979).

Crotoxin, the neurotoxin from Crotalus durissus terrificus venom, and its two subunits, crotoxin A and crotoxin B, have been examined by fluorescence and circular dichroism techniques. Model spectra of crotoxin, generated from the expected contributions of the individual subunits, agreed with experimental results only at pH 2, where crotoxin was fully dissociated. From pH 4 to 10, crotoxin spectra could not be simulated by subunit contributions. Comparison of the results at pH values favoring either association or dissociation indicated that complex formation was accompanied by: (1) a 70% decrease in fluorescent emission intensity and a 7-nm blue shift of the emission maximum, (2) an increase in the far-ultraviolet circular dichroism, and (3) a marked intensity enhancement of the near-ultraviolet circular dichroism spectrum. These observations were taken as evidence that tryptophan residues were masked by complex formation and that the crotoxin complex contained an increased proportion of ordered secondary structure, particularly β sheets. The results did not distinguish between conformational changes with subunit interaction or creation of ordered structure only at the subunit binding interface. Structural flexibility of the subunits was suggested from their ability to undergo reversible state changes by exposure to acid pH or guanidine hydrochloride. Examination of the concentration dependence of guanidine hydrochloride denaturation indicated that complex formation gave increased stability, although the subunits were individually quite resistant to guanidine hydrochloride denaturation. It is concluded that the ability of crotoxin and its subunits to exist in several reversible states is related to the control of the association-dissociation equilibrium of the complex and that conformational interconversion may be necessary for crotoxin to act on different target membranes.

12555 (UCD—472-125, pp 95-96) **Production of a mesenchymal tumor in a nude mouse by the injection of stromal cells obtained from a lymph node of a beagle with malignant lymphoma.** Klein, A.K.; Wilson, F.D.; Shifrine, M.; Hinds, D. Oct 1979.

In Annual report, 1978-1979.

An extension of our model for the investigation of stromal elements in lymphohematopoiesis by the inoculation of attaching cells isolated from tissue cultures into athymic (nude) mice is described. The nude mouse transplantation model was originally developed for the study of human hematopoietic stromal elements and is shown in this report to be useful for the study of lymphohematopoietic stromal elements in the dog as well.

12556 (UR—3490-1692) **Molecular mechanism by which cyclic amp regulates myocardial contractility.** Bidlack, J.M. (Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics). 1979. Contract EY-76-C-02-3490. 142p. Dep. NTIS, PC A07/MF A01.

Thesis.

From these experiments, it appears that the phosphorylated 22,000 dalton protein does not regulate the transport properties of the ATPase. Instead phosphorylation of the 22,000 dalton protein causes it to become buried in the membrane, transporting Ca^{2+} into the sarcoplasmic reticulum and thereby, elevating the Ca^{2+} concentration in the sarcoplasmic reticulum available for release to the myofibrils.

12557 **Binding of immunoglobulin G to phospholipid vesicles by sonication.** Huang, L. (Univ. of Tennessee, Knoxville); Kennel, S.J. Contract W-7405-ENG-26. *Biochemistry;* **18**: No. 9, 1702-1707(1 May 1979).

Purified goat immunoglobulin G (IgG) does not bind to sonicated phospholipid vesicles. However, when IgG is sonicated together with phospholipids, 4 to 40% of the IgG can be bound to the vesicles, depending on the experimental conditions. The extent of binding depends on the period and power of sonication, the IgG to lipid ratio, and the lipid composition. Anionic phospholipids such as phosphatidylglycerol and phosphatidylserine, but not cholesterol, enhance binding about 50% over that obtained with the neutral phosphatidylcholine. Binding of IgG causes extensive aggregation of vesicles, as shown by electron microscopy, and aggregates can be separated from unbound IgG by molecular-sieve chromatography on Sepharose 4B or by sucrose density gradient centrifugation. The

IgG-vesicle aggregates remain stable in either phosphate-buffered saline or 50% fetal calf serum up to 20 h at 37°C, although substantial lipid degradation in 50% fetal calf serum was observed. The use of goat IgG containing antibody to a purified protein antigen allowed quantitation of antibody activity of these preparations. Immune IgG sonicated alone shows 100% of the original antigen binding capacity while vesicle-bound IgG retains 30 to 50%. Antigen binding capacity of bound IgG is not increased when vesicles are lysed by 1.5% NP-40, suggesting all of the bound IgG is exposed on the outer surfaces of the vesicles. IgG's of human, mouse, and rabbit, as well as the purified goat $F(ab')_2$ fragments, also bind with vesicles by cosonication.

12558 Influence of substitution at C_{24} on the calcium-binding protein-stimulating activity of vitamin D metabolites in chick embryonic duodenum. Parkes, C.O. (Univ. of British Columbia, Vancouver); Deluca, H.F. *Arch. Biochem. Biophys.;* **194**: No. 1, 271-274(1979).

The production of calcium-binding protein, in vitro, by embryonic chick duodenum has been used to assess the potency of vitamin D compounds. The introduction of an hydroxyl on 1-, 25-, or 24R-position enhanced biological activity while the introduction of both 1α- and 25-hydroxyls produced maximal activity. However, 24R-hydroxylation of 1,25-dihydroxyvitamin D_3 diminished activity. The vitamin D_2 side chain on 25-hydroxy-vitamin D or 1,25-dihydroxyvitamin D did not greatly diminish activity in contrast to the fact that the vitamin D_2 compounds are 10% as active as the vitamin D_3 compounds in vivo in the chick. These results support the idea that the target organs of the chick do not discriminate against the vitamin D_2 side chain and that the discrimination in this species is at the level of metabolism.

12559 On the physiological role of 1,24,25-trihydroxyvitamin D_3. Castillo, L. (Univ. of Wisconsin, Madison); Tanaka, Y.; DeLuca, H.F.; Ikekawa, N. *Miner. Electrolyte Metab.;* **1**: 198-207(1978).

The extent, onset and duration of the biological activity of 1,24(R),25-trihydroxyvitamin D_3, 1,24(S),25-trihydroxyvitamin D_3 has been compared with that of 1,25-dihydroxyvitamin D_3 in the elevation of serum phosphorus, healing of rickets, stimulation of intestinal calcium transport, mobilization of calcium from bone in vitamin D-deficient rats and induction 25-hydroxyvitamin D_3-24-hydroxylase in chickens. The 1,24,25-trihydroxyvitamin D_3 S and R isomers are approximately equal in activity but both are less active than 1,25-dihydroxyvitamin D_3. In some systems their duration of activity is also less than that of 1,25-dihydroxyvitamin D_3. The time course of response to the 3 forms of vitamin D is approximately equal. These results strongly suggest that 1,24(R),25-trihydroxyvitamin D_3 is not a further activation product of 1,25-dihydroxyvitamin D_3, but is likely a product leading to inactivation.

12560 Conformation examination of uridine diphosphoglucose using lanthanide-nitrilotriacetate chelates as shift probes. London, R.E.; Sherry, A.D. (Los Alamos Scientific Lab., NM). *Biochemistry;* **17**: No. 17, 3662-3666(1978).

A ^{13}C NMR study utilizing the lanthanide-induced shift (LIS) technique was carried out on uridine diphosphoglucose (UDPG) in order to determine the solution conformation. The neutral water soluble nitrilotriacetate chelates, Ln(NTA), were used in preference to the bare ions due to the potency of the latter in hydrolyzing the UDPG. In addition to the primary binding site at the pyrophosphate moiety, secondary binding to the uracil carbonyl groups was observed and found to be a function of the size of the lanthanide ion; the largest ions showed the greatest relative affinity for the carbonyl groups. This effect was overcome by extrapolating the observed shift ratios to zero Ln(NTA)/[UDPG]. The extrapolated shift ratios were relatively constant for a series of five lanthanides indicating the solution conformation of UDPG is insensitive to metal ion size. The conformation of the UDPG was found to be extended so that the uracil carbons as well as carbons 1', 2', and 3' of the ribose are outside of the pseudo-contact shift cone with the remaining carbons inside the cone.

12561 Pathways of DNA repair in yeast. Prakash, L.; Prakash, S. (Univ. of Rochester, NY). pp 413-416 of DNA repair mechanisms. Hanawalt, P.C.; Friedberg, E.C.; Fox, C.F. (eds.). New York, NY; Academic Press, Inc. (1978).

The RAD1 excision-repair pathway of yeast consists of three additional genes, RAD7, RAD14, and MMS19, all of which are shown to be defective in excision of pyrimidine dimers. In addition, two genes, MMS3 and CDC8 are discussed in terms of their effect on uv-induced mutations.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 12590, 12627, 12685

12562 (UR—3490-1689) I. Use of m- and p-azidobenzamidines, 4-fluoro-3-nitro-phenylazide, and 3-azido-1,2,4-triazole as photoaffinity probes of tryptic binding site conformation. II. Analysis of tryptophan in proteins by an acidic reaction of 3-diazonium-1,2,4-triazole. DeTraglia, M.C. (Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics). 1979. Contract EY-76-C-02-3490. 142p. Dep. NTIS, PC A07/MF A01.

Thesis.

Meta- and para-azidobenzamidine have been prepared and evaluated as photoaffinity labels. The compounds inhibit trypsin reversibly in the dark and are competitive with substrate binding. Upon photolysis, irreversible noncompetitive inhibition is observed and is dependent upon concentration, photolysis time, and pH. Specificity of the probes is indicated by experiments in which p-tosyl-L-arginine methyl ester, a trypsin substrate, is used to protect against photoinactivation.

12563 (UR—3490/LCP-15) Interaction between the catalytic and ion transport sites of the adenosine triphosphatase of sarcoplasmic reticulum. Scott, T.L. (Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics). 1979. Contract EY-76-C-02-3490. 247p. Dep. NTIS, PC A11/MF A01.

Thesis.

The goal of this thesis is the elucidation of the mechanism of energy transduction between the ATP catalytic site and the ion transport sites of the Ca^{2+}-Mg^{2+} ATPase of skeletal muscle sarcoplasmic reticulum (SR). Modification of the ATPase peptide by thiol group blockage with mercurial reagents and proteolytic fragmentation with trypsin is used to perturb the interactions between the hydrolytic and transport processes.

12564 Heterogeneity of radioiodinated parathyroid hormone in rat plasma. Barrett, P.Q.; Teitelbaum, A.P.; Neuman, W.F. (Univ. of Rochester School of Medicine and Dentistry, NY). *Metab. Bone Dis. Relat. Res.;* **1**: 263-267(1978).

Parathyroid hormone has been reported to occur in plasma as a mixture of intact hormone and fragments most of which exhibit a molecular weight around 6000. The present studies were undertaken to clarify the origins of these fragments. Labeled hormone was found to generate the 6000 molecular weight fragment(s) presumably by peripheral proteolytic degradation. It was found that the 6000 molecular weight fragment(s) never exceeded the concentration of the intact hormone in the circulation of the rat and that a widely used chromatographic system (non-denaturing) underestimates the proportion of intact hormone present in plasma samples. This finding is of direct significance to elution profile analysis by radioimmunoassay.

CYTOLOGY

12565 (LBL—9888) Membrane organization of cytochrome c oxidase. Swanson, M.S. (California Univ., Berkeley (USA); California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1979. Contract W-7405-ENG-48. 220p. Dep. NTIS, PC A10/MF A01.

Thesis.

The membrane organization of mitochondrial cytochrome c oxidase and the role of intracomplex, intercomplex, rotational and lipid versus protein motion to that organization, has been investigated by amino acid chemical modification and electron paramagnetic resonance. Crosslinking of purified and reconstituted cytochrome c oxidase and mitochondria with biimidates, in the presence and absence of cytochrome c, has been used to investigate oxidase subunit interactions, and whether cytochrome c mobility is required for electron transport activity. The rotational mobility of spin-labeled oxidase in purified form, and incorporated into liposomes, was also studied to gain information on the membrane organization of oxidase. These findings have led to a model for the structure and membrane organization of cytochrome oxidase, and the role of cytochrome c rotational and/or translational motion on the mitochondrial inner membrane surface.

12566 (UCD—472-125, pp 97) Production of jojoba wax in tissue culture. Rost, T.L.; Lambert, C.; Wrightson M.; Shifrine, M. Oct 1979.

In Annual report, 1978-1979.

This report covers a portion of a larger study dealing with the induction of wax synthesis in cultured jojoba cells, and is concerned with the production of callus and the morphogenetic and physiological changes which cotyledon segments undergo during the first thirty days in culture.

12567 Determination of the pore size of cell walls of living plant cells. Carpita, N.; Sabularse, D.; Montezinos, D.; Delmer, D.P. (Michigan State Univ., East Lansing). Contract EY-76-02-C-1338. *Science;* **205**: 1144-1147(14 Sep 1979).

The limiting diameter of pores in the walls of living plant cells through which molecules can freely pass has been determined by a solute exclusion technique to be 35 to 38 angstroms for hair cells of Raphanus sativus roots and fibers of Gossypium hirsutum. 38

to 40 angstroms for cultured cells of Acer pseudoplatanus, and 45 to 52 angstroms for isolated palisade parenchyma cells of the leaves of Xanthium strumarium and Commelina communis. These results indicate that molecules with diameters larger than these pores would be restricted in their ability to penetrate such a cell wall, and that such a wall may represent a more significant barrier to cellular communication than has been previously assumed.

12568 bg/sup J//bg/sup J/:W/W/sup v/ bone marrow chimera. A model for studying stem cell regulation. Patt, H.M.; Maloney, M.A. (Univ. of California, San Francisco). *Blood Cells;* **4**: 27-35(1978).

In studies with bg/sup J//bg/sup J/:W/W/sup v/ chimeric mice, we used the beige neutrophil marker as a criterion of W/W/sup v/ marrow replacement by implanted bg/sup J//bg/sup J/ stem cells. Data from a 50-fold range of inoculum doses and a 2 y period of observation indicate a hyperbolic pattern of replacement expressed as a log dose-response relationship. The saturating effect with increasing inoculum dose was interpreted as reflecting random initial stem cell seeding in bone marrow coupled with a decreasing efficiency of colonization by migration. From the statistics of random sampling and the exponential decrease of the 63% replacement dose with time, we estimate that W/W/sup v/ marrow contains about 2600 stem cell regulatory volumes of about $10^8\ \mu^3$ (50 cell diameters) each, a dimension consistent with concepts of short-range cell-cell interactions. Our observations suggest that each regulatory volume is essentially self-contained and that stem cell migration is generally restricted to contiguous volumes.

GENETICS

REFER ALSO TO CITATION(S) 12584, 12686

12569 Nicotiana chromosome coding for a specific polypeptide of the small subunit of fraction 1 protein. Chen, K. (Univ. of California, Los Angeles); Sand, S.A. *Science;* **204**: 179-180(13 Apr 1979).

Fraction 1 protein has been isolated from leaves of a male sterile Nicotiana tabacum plant containing an extra N. debneyi chromosome. The extra chromosome induces appearance of a third polypeptide composing the small subunit of fraction 1 protein, which otherwise contains two polypeptides as is shown by analysis of numerous different cultivars of N. tabacum.

METABOLISM

TRACER TECHNIQUES

12570 (N—79-16544) **Kinetic measurements of bone mineral metabolism: the use of Na-22 as a tracer for long-term bone mineral turnover studies. Final report, 7 April-30 November 1978.** Palmer, H.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 30 Nov 1978. Contracts NAS9-15544;NAS9-14248. 24p. NTIS, PC A02/MF A01.

Sodium-22 was studied as a tracer for bone mineral metabolism in rats and dogs. When incorporated into bone during growth from birth to adulthood, the bone becomes uniformly tagged with (22)Na which is released through the metabolic turnover of the bone. The (22)Na which is not incorporated in the bone matrix is rapidly excreted within a few days when animals are fed high but nontoxic levels of NaCl. The (22)Na tracer can be used to measure bone mineral loss in animals during space flight and in research on bone disease.

MEDICINE

REFER ALSO TO CITATION(S) 12574, 12605

12571 (METC—8087-T1) **Final report ending June 30, 1979.** Friedman, M.H. (West Virginia Univ., Morgantown (USA). Medical Center). 4 Oct 1979. Contract EY-77-C-21-8087. 8p. Dep. NTIS, PC A02/MF A01.

Portions of document are illegible.

The primary objective was to evaluate new pulmonary function measurements. The evaluation procedure was two fold: (1) evaluate a different animal species (rabbit), and (2) produce a lung disease and determine whether the new tests were sensitive to the changes in the lung which took place during the disease. We have completed the work with minor changes and have met the two main objectives of the contract. Firstly, all four animal species studied showed the same general phenomenon of gas trapping at positive transpulmonary pressures. Secondly, one disease process of the lungs was shown to dramatically alter the amounts and times of gas trapping. This additional information is a strong indication that these new tests will be useful in following changes in the lungs when and if they occur as a result of exposure to bag house dust collected from pilot coal gasification plants.

UNSEALED RADIONUCLIDES IN DIAGNOSTICS

REFER ALSO TO CITATION(S) 12624

12572 (NTISUB/E/228—001) **The role of computed axial tomography in the detection, diagnosis, and therapy of cancer. Oncology overview.** (National Cancer Inst., Bethesda, MD (USA). International Cancer Research Data Bank). 8 May 1979. 63p. NTIS, PC A04/MF A01.

ONCOLOGY OVERVIEWS are a service of the International Cancer Research Data Bank (ICRDB) Program of the National Cancer Institute. Each ONCOLOGY OVERVIEW represents a survey of the literature associated with a selected area of cancer research. It contains abstracts of articles which have been selected and organized by researchers associated with the field. The purpose of this OVERVIEW is to facilitate and promote the exchange of information between cancer scientists by keeping them aware of literature related to their research being published by other laboratories thrcughout the world. Contents: Physics--system design and image reconstruction, General applications of head scanning, Pediatric applications of head scanning, Brain scanning--anatomical and pathological correlations in diagnosis, Orbital lesions, Head and neck lesions, General applications of body scanning, Comparisons of CAT with radionuclide and ultrasonic scanning, Contrast enhancement, Role in therapy planning and evaluation, Radiation exposure dosimetry, Positron, proton, and gamma scanning.

12573 Rapid clearance of advanced pelvic carcinomas by low dose rate ^{252}Cf neutron therapy. Maruyama, Y. (Univ. of Kentucky, Lexington). *Radiology;* **133**: No. 2, 473-475(Nov 1979).

Californium 252 low dose rate intracavitary neutron implants combined with conventional external beam therapy for advanced pelvic tumors produced better local response than ^{137}Cs in pelvic brachytherapy. Greater tumor regression was achieved by applying ^{252}Cf while the maximum amount of tumor was present preceding or shortly after starting external beam therapy (12/14 or 86%). This schedule was more effective than similar neutron doses given after external beam irradiation.

12574 (ORNL/TM—6771) **Nuclear medicine technology. Progress report for quarter ending December 31, 1978.** Knapp, F.F. Jr. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 24p. Dep. NTIS, PC A02/MF A01.

Of special interest is the recent synthesis of /sup 117m/Sn-labeled 12,12-dimethyl-12-stannahexadecanoic acid. Although tissue distribution studies with this potential myocardial imaging agent demonstrated only marginal heart uptake of radioactivity, these studies are important since they clearly demonstrate that tissue-specific /sup 117m/Sn-labeled agents can be prepared. High-quality heart scans in rats that have been obtained following intravenous administration of /sup 123m/Te-labeled 9-tellurahepta-decanoic acid are also illustrated. Continuing studies with ^{11}C and /sup 195m/Pt are described. Additional patient studies with ^{11}C-DL-tryptophan and ^{11}C-1-aminocyclobutanecarboxylic acid (^{11}C-ACBC) have further illustrated the usefulness of these agents for the positron emission tomographic imaging studies of the pancreas and tumor tissue, respectively. Studies of the reactor production of /sup 195m/Pt by the Szilard-Chalmers process have been completed. These studies have demonstrated that the preparation of high specific activity /sup 195m/Pt by the Szilard-Chalmers process using this technique is impractical. Finally, continued studies with the KB tumor cell diffusion chamber technique have shown that a dose-response relationship can be demonstrated following injection of both cyclophosphamide and cis-dichlorodiammineplatinum (II). These results suggest that the diffusion chamber technique could be an important tool to study the uptake and effects on cell growth of radiopharmaceuticals and other agents.

12575 (ORNL/TM—7072) **Nuclear medicine technology. Progress report for quarter ending September 30, 1979.** Knapp, F.F. Jr. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 29p. Dep. NTIS, PC A03/MF A01.

Adrenal uptake in rats of /sup 117m/Sn-labeled 23-(trimethyl stanna)-24-nor-5α-cholan-3β-o1 is demonstrated. The adrenal:blood and adrenal:liver ratios were 33:1 and 9:1, only one day after intravenous administration. A variety of /sup 117m/Sn-labeled steroids with structural modifications were also prepared to determine their effects on the adrenal uptake of these unusual steroids. Structural features required for significant adrenal uptake were determined. The diffusion chamber assay system has been assessed as a means of investigating the toxicity and biological fate of trace elements from energy technologies. In a preliminary experiment, the cell population in chambers from rats exposed to As_2O_3 was inhibited 48% one day after treatment. The results of continuing studies with ^{75}Se, ^{11}C, and /sup 195m/Pt-labeled agents are also described.

Several ^{75}Se-labeled long-chain fatty acids were prepared to determine heart uptake. Selenium-75-labeled 9-selenapentacosanoic acid showed the highest uptake of the compounds investigated. Preliminary radiation dose estimates have been performed for several ^{75}Se and /sup 123m/Te-labeled fatty acids. Tissue distribution and excretion data for ^{75}Se-labeled 9-selenaheptadecanoic acid and /sup 123m/Te-labeled 9-telluraheptadecanoic acid indicate that the human liver would recieve the highest absorbed radiation dose.Tissue distribution studies in rats with a series of /sup 195m/Pt-labeled chloroammine complexes have demonstrated that the tissue distribution and excretion characteristics of the chlorcammine complexes closely parallel their physicochemical properties. Further patient studies have assessed the efficacy of emission computerized tomographic organ imaging with ^{11}C-valine, and ^{11}C-amino-cyclobutanecarboxylic acid (ACBC). (ERB)

12576 (PB—290955) **Imaging of ability of collimators in nuclear medicine. Supplementary collimator data for rectilinear scanners. Final report.** Ehrhardt, J.C.; Oberley, L.W.; Cuevas, J.M. (Iowa Univ. Hospitals and Clinics, Iowa City (USA). Dept. of Radiology). Dec 1978. Contract FDA-223-75-6038. 131p. NTIS, PC A07/MF A01.

The supplement covers rectilinear scanner collimators only, and contains the complete line spread function (LSF) and modulation transfer function (MTF) data synopsized in Table 2 of HEW Publication (FDA) 79-8077. Reference should be made to this publication for a description of data collection methods and for information or interpretation and use. Gamma camera collimators are covered in the primary publication.

12577 (PB—292001) **Handbook of mammographic x-ray spectra. Final report.** Fewell, T.R.; Shuping, R.E. (Bureau of Radiological Health, Rockville, MD (USA)). Oct 1978. 114p. NTIS, PC A06/MF A01.

The handbook is a compendium of experimentally acquired and corrected x-ray spectra obtained from three conventional mammographic x-ray tubes (tungsten, molybdenum-tungsten, and molybdenum targets) and from a special purpose tube often used for mammography (RSI tungsten anode). The experimental data are divided into five parts. The first section presents graphical displays of exposure data (mR/mAs at 1 meter) that correspond to experimental spectra. The second section describes and compares parameters of 30 kVp x-ray beams produced by the anode material types used in mammographic tubes. The third section describes the data format used for displaying the graphical overlays and for the numerical tabulation of x-ray spectra. In the fourth section specifically selected spectral overlays are used to (1) compare the energy content of x-ray beams produced by different anode materials and x-ray systems, (2) illustrate x-ray beam shaping by using K-edge filters, and (3) demonstrate x-ray beam hardening with phantom materials. The last section contains numerical tabulations of x-ray spectra produced by mammographic tubes. While these spectra may not be inclusive they should be representative of a range of mammographic techniques of each tube and system tested. The additional information contained with each tabulation should make it possible for the experimenter to simulate each spectrum by measuring the kVp, filtration, and HVL of the x-ray beam.

12578 (PB—293737) **Quantification of ischemic and infarcted myocardium. Report no. 9 (final), 30 jun 75-31 dec 77.** Harper, P.V. (Chicago Univ., IL (USA). Pritzker School of Medicine). 15 Nov 1978. Contract N01-HV-52980. 122p. NTIS, PC A06/MF A01.

An instrument for positron emission tomography has been developed in collaboration with G. Muehllehner of Searle Radiographics Inc. which consists of two modified gamma cameras mounted in a rotating gantry and connected in coincidence. The electronic and mechanical development was carried out by Searle, the testing, software development and initial trials were a collaborative effort. The principal accomplishments consisted of: Demonstration of the practicality of myocardial imaging with a variety of agents 81Rb+, 13 0Cs+, 13NH4+, N-13 asparagine; software was developed which permitted quantitative tomography both in transverse and longitudinal modes; validation studies were carried out in a porcine model demonstrating that 13NH4+ uptake appears to be a good marker for flow, and clinical pilot studies in recovering, ambulatory patients with myocardial infarction demonstrated vastly improved visualization of the myocardium.

12579 (UCD—472-125, pp 22-25) **Cyclotron target system for the synthesis of ^{13}N labeled ammonia, dinitrogen, nitrite and nitrate.** Parks, N.J.; Krohn, K.A. Oct 1979.

In Annual report, 1978-1979.

The utility of radioactive ^{13}N(T/sub 1/2/ = 10 min) as a tracer in environmental studies is well recognized. In our laboratory, labeled ammonium ion solutions with ^{13}N radioactivity concentrations > 20 μCi mm^{-3} were required for in vivo measurements of hygroscopic aerosol growth phenomena. This report describes a cyclotron target system that was fabricated for production of biologically useful quantities of $^{13}NH_4^+$, as well as $^{13}N^{14}N$, $^{13}NO_2^-$, and $^{13}NO_3^-$.

12580 **Solid phase separation technique for use in radioimmunoassays.** Tu, J.I. (to E.R. Squibb and Sons, Inc.). US Patent 4,166,844. 4 Sep 1979. Filed date 18 Apr 1977. 8p.

A radioimmunoassay procedure, and article of manufacture for carrying out that procedure, are disclosed herein. The solid phase separation technique utilized in the radioimmunoassay of this invention utilizes a test tube, the internal surface of which has been coated with two antibody layers.

EXTERNAL RADIATION IN THERAPY

REFER ALSO TO CITATION(S) 12572

12581 (PB—292007) **Implanted energy conversion system. Annual report, 1 May 1977-1 May 1978.** Johnston, R.P.; Bennett, A.; Emigh, S.G.; Englesby, G.M.; Gray, D.H. (Joint Center for Graduate Study, Richland, WA (USA). Richland Energy Lab.). Jan 1979. Contract N01-HV-4-2901. 235p. NTIS, PC A11/MF A01.

The REL power source combines the high efficiency of Stirling engines with the reliability, efficiency, flexibility, and energy density of hydraulic power transfer and control to ensure long system life and physiological effectiveness. Extended life testing has been achieved with an engine (3.6 years) and hydraulic actuator/controller (4.9 equivalent years). Peak power source efficiency is 15.5 percent with 5.10 watts delivered to the blood pump push plate for 33 watts steady thermal input. An automatic engine output flow controller on the current System 6 engine module has demonstrated the capability of following a typical daily duty cycle with 24.7 watts average thermal input. Animal in-vivo tests with an assist heart have consistently demonstrated required performance by biological synchronization and effective ventricle relief. An operating engine has functioned at full capacity for 29 days in vivo. Volume and weight of the System 6 engine module are 0.93 liter and 2.4 kg with an additional 0.4 liter of low temperature foam insulation required to preclude tissue thermal damage. Major size reduction is planned for System 7.

MICROBIOLOGY

REFER ALSO TO CITATION(S) 12134, 12551

12582 (BNL—26964) **Chlorophyll, bacteriochlorophyll, or protochlorophyll.** Olson, J.M. (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 8p. Dep. NTIS, PC A02/MF A01.

The question of which chlorophyll came first in the evolution of photosynthesis is discussed. It has been assumed that bacteriochlorophyll a came first, because the earliest photosynthetic organisms are thought to have been obligatory anaerobes. The writer proposes that the common ancestor of all photosynthetic prokaryotes and organelles contained protochlorophyll a, and that all green and purple photosynthetic bacteria are descended from a bacteriochlorophyll a - containing ancestor which diverged from the chlorophyll a line leading to blue-green algae and chloroplasts. (ACR)

12583 (COO—2311-30) **Membrane-membrane interactions in a lipid-containing bacteriophage system. Progress report, October 1, 1978-September 30, 1979.** Snipes, W. (Pennsylvania State Univ., University Park (USA). Coll. of Science). Jun 1979. Contract EY-76-S-02-2311. 6p. Dep. NTIS, PC A02/MF A01.

Progress is reported on research on two aspects of the life cycle of PM2, a lipid-containing bacteriophage. The first concerns the initial interaction of PM2 with the outer membrane of its host cell, Pseudomonas BAL-31. The second concerns the assembly of PM2 in infected cells and the structural features of hydrophobic membrane perturbers that inhibit PM2 assembly. Several other projects have been completed: distribution of PM2 receptors; effects of adamantance derivatives on PM2 production; hydrophobic membrane perturbers as antiviral and virucidal agents; hydrophobic photosensitizers; and other technique development. (ACR)

12584 (COO—4198-9) **Degradation of cellulosic biomass and its subsequent utilization for the production of chemical feedstocks. Progress report, December 1, 1978-February 28, 1979.** Wang, D.I.C.; Cooney, C.L.; Demain, A.L.; Gomez, R.F.; Sinskey, A.J. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nutrition and Food Science). Feb 1979. Contract EG-77-S-02-4198. 176p. Dep. NTIS, PC A09/MF A01.

The ongoing progress of a coordinated research program aimed at optimizing the biodegradation of cellulosic biomass to ethanol and chemical feedstocks is summarized. Growth requirements and genetic manipulations of clostridium thermocellum for selection of high cellulose producers are reported. The enzymatic

activity of the cellulase produced by these organisms was studied. The soluble sugars produced from hydrolysis were analyzed. Increasing the tolerance of C. thermocellum to ethanol during liquid fuel production, increasing the rate of product formation, and directing the catabolism to selectively achieve high ethanol concentrations with respect to other products were studied. Alternative substrates for C. thermocellum were evaluated. Studies on the utilization of xylose were performed. Single stage fermentation of cellulose using mixed cultures of C. thermocellum and C. thermosaccharolyticum were studied. The study of the production of chemical feedstocks focused on acrylic acid, acetone/butanol, acetic acid, and lactic acid.

12585 Production of cellulase by a thermophilic Thielavia terrestris. Skinner, W.A.; Tokuyama, F. (to Stanford Research Inst.). US Patent 4,081,328. 28 Mar 1978. Filed date 8 Sep 1976. 8p.

A thermostable cellulase preparation exhibiting C_1 and C/sub x/ cellulytic activities at a temperature from about 60° to about 70°C at a moderately acid pH from about 5.0 to about 5.6 is obtained by culturing the thermophilic fungus Thielavia terrestris (NRRL 8126) in a suitable cellulose-containing medium and recovering the cellulases thus produced.

MORPHOLOGY

REFER ALSO TO CITATION(S) 12660

PATHOLOGY

12586 (UCD—472-125, pp 90-94) **Granulopoietic effects of fibroblastic colonies in normal humans and in patients with acute myelogenous leukemia and myeloproliferative disorders.** Greenberg, B.R.; Wilson, F.D.; Woo, L. Oct 1979.

In Annual report, 1978-1979.

The granulopoietic effects of fibroblastic colonies on CFU-C were studied in vitro in normal humans and in patients with acute myelogenous leukemia (AML) and myeloproliferative disorders. To determine their influence on granulopoiesis we obtained FC in liquid culture from normals and patients with AML, pre-leukemia, myeloproliferative disorders (MPD) and metastic carcinoma and overlaid them with normal and leukemic human marrow cells in agar measuring the number of CFU-C. Increased numbers of CFU-C were found above the FC obtained from normals with no growth greater than control in those areas lacking FC. FC obtained from untreated AML failed to enhance granulopoiesis in contrast to the stimulation produced by FC from AML in remission. FC from patients with MPD had little effect on granulopoiesis. Occasional normal appearing colonies were observed when leukemic target cells were used in the overlay. The addition of FC to placenta conditioned media never augmented granulopoiesis further and frequently was inhibitory. The supernatant from normal FC had a minimal effect on colony growth and when obtained from patients with pre-leukemia and untreated AML, no effect was noted. These studies indicate that FC were capable of enhancing granulopoiesis and in AML marked differences are observed depending on the status of the disease. Furthermore, the effects of FC on granulopoiesis appear to be local, are not synergistic with colony stimulating activity for the total number of colonies but are synergistic for colony size. The interaction of cells of stromal origin with hematopoietic progenitors may be important in the clinical expression of hematological malignancies.

TRACER TECHNIQUES

12587 (UCLA—12-1227) **Epileptic patterns of local cerebral metabolism and perfusion in man determined by emission computed tomography of ^{18}FDG and $^{13}NH_3$.** Kuhl, D.E.; Engel, J. Jr.; Phelps, M.E.; Selin, C. (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology). 1979. Contract EY-76-C-03-0012. 44p. Dep. NTIS, PC A03/MF A01.

Seventeen patients with partial epilepsy had EEG monitoring concurrent with cerebral emission computed tomography (ECT) after ^{18}F-fluorodeoxyglucose (^{18}FDG) and ^{13}N-ammonia were given intravenously as indicators of local cerebral glucose utilization (LCMR/sub glc/) and relative perfusion, respectively. In 12 of 15 patients who had unilateral or focal electrical abnormalities, interictal ^{18}FDG scan patterns clearly showed localized regions of decreased (20% to 50%) LCMR/sub glc/, which correlated anatomically with the eventual EEG localization. These hypometabolic zones appeared normal on x-ray computed tomography in all but three patients and were unchanged on scans repeated on different days. In 5 of 6 patients who underwent temporal lobectomy, the interictal ^{18}FDG scan correctly detected the pathologically confirmed lesion as a hypometabolic zone, and removal of the lesion site resulted in marked clinical improvement. In contrast, the ictal ^{18}FDG scan patterns clearly showed foci of increased (82% to 130%) LCMR/sub glc/, which correlated temporally and anatomically with ictal EEG spike foci and were within the zones of interictal hypometabolism (3 studies in 2 patients). $^{13}NH_3$ distributions paralleled ^{18}FDG increases and decreases in abnormal zones, but $^{13}NH_3$ differences were of lesser magnitude. When the relationship of $^{13}NH_3$ uptake to local blood flow found in dog brain was applied as a correction to the patients' $^{13}NH_3$ scan data, local alterations in perfusion and glucose utilization were usually matched, both in the interictal and ictal states.

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 12559, 12571, 12678, 12683

12588 (UCD—472-125, pp 87-89) **Morphological studies on attaching cells in bone marrow cultures obtained from humans, canines and mice.** Wilson, F.D.; Tavassoli, M.; Greenberg, B.R.; Hinds, D. Oct 1979.

In Annual report, 1978-1979.

The results of scanning electron microscopic studies on attaching cells obtained from cultures of bone marrow from humans, dogs and mice are presented. The morphology of these cells was similar in humans and dogs but differed from mice. These cells in humans and dogs were morphologically much more homogeneous, more tightly attached or flattened than in mice. The relationship of these observations to previous studies on attaching cells is discussed.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 12587

12589 (UCLA—12-1232) **Positron emission tomography of the heart.** Schelbert, H.R.; Phelps, M.E.; Kuhl, D.E. (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology). 1979. Contract EY-76-C-03-0012. 34p. Dep. NTIS, PC A03/MF A01.

Positron emission computed tomography (PCT) represents an important new tool for the noninvasive evaluation and, more importantly, quantification of myocardial performance. Most currently available techniques permit assessment of only one aspect of cardiac function, i.e., myocardial perfusion by gamma scintillation camera imaging with Thallium-201 or left ventricular function by echocardiography or radionuclide angiocardiography. With PCT it may become possible to study all three major segments of myocardial performance, i.e., regional blood flow, mechanical function and, most importantly, myocardial metabolism. Each of these segments can either be evaluated separately or in combination. This report briefly describes the principles and technological advantages of the imaging device, reviews currently available radioactive tracers and how they can be employed for the assessment of flow, function and metabolism; and, lastly, discusses possible applications of PCT for the study of cardiac physiology or its potential role in the diagnosis of cardiac disease.

12590 Effect of age on calcium absorption and accumulation of 1,25-dihydroxyvitamin D_3 in intestinal mucosa of rats. Horst, R.L.; DeLuca, H.F.; Jorgensen, N.A. (Univ. of Wisconsin, Madison). *Metab. Bone Dis. Relat. Res.;* **1**: 29-33(1978).

Calcium transport in the proximal duodenum was measured in male rats of various ages by the everted intestinal sac method. Calcium transport markedly and progressively diminished from 54 days to 384 days of age despite adequate intakes of vitamin D_3 (10 IU/day). Additionally, feeding low phosphorus and/or low calcium diets for 24 days did not result in an enhanced calcium transport in old (1 year) rats while showing the expected enhancement in young rats (24 days). The administration of 325 pmoles of either 1,25-dihydroxyvitamin D_3 or 1α-hydroxyvitamin D_3 daily increased intestinal calcium transport in both young and old rats. This response was accompanied by increases serum calcium in young rats and increased serum phosphorus in old rats. Administration of vitamin [1,2^{3}H]D_3 daily (10 IU) for 6 days orally and chromatography of the extracts of serum and intestine permitted the demonstration that the diminished calcium transport with age is positively correlated with diminished levels of 1,25-dihydroxy-[1,2^{3}H]D_3 in serum and intestinal mucosa. It appears that the decreased intestinal absorption with age is a result of a diminished formation of 1,25-dihydroxyvitamin D_3. The inability of aged rates to alter this condition under dietary depletion of calcium and/or phosphorus may play a significant role in the development of bone disease in the aged.

PUBLIC HEALTH

REFER ALSO TO CITATION(S) 12671, 12898

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 11576, 11577, 11578, 11579, 12221, 12498, 12546, 12569, 12650, 12652

12591 (BMI—2033(Vol.1)) **Systems study of the potential integration of US corn production and cattle feeding with manufacture of fuels via fermentation.** Lipinsky, E.S.; Scantland, D.A.; McClure, T.A. (Battelle Columbus Labs., OH (USA)). 4 Jun 1979. Contract W-7405-ENG-92-077. 147p. Dep. NTIS, PC A07/MF A01.

The results of a study of the feasibility of making corn grain available for conversion into motor fuel ingredients without undue disruption of the price structure for beef and other meat products that are now dependent on inexpensive corn grain are presented. Corn grain for cattle feeding would be replaced by corn stover and supplemented with distillers dried grains and solubles (DDGS), a by-product of ethanol fermentation from corn grain. Thus, the unique capability of ruminant animals to use cellulose as the carbon source for meat production could be exploited, and as a result of ethanol fermentation, the protein contained in the corn grain and in the yeast could be used for livestock production. The nutritional value of corn stover in mixtures with DDGS probably would not satisfy the needs of feedlot operators. However, the high potential of the proposed system, and concern over the validity of existing corn stover nutritional data, strongly justifies cattle feeding trials. Upgrading of corn stover by the Iotech Process, Purdue Process, or alkali could increase the nutritional value but also would increase the cost of the cellulose material. The production of even one billion gallons of ethanol from corn grain in Midwestern states would lead to six times the present production of DDGS. This additional DDGS would compete with soybean meal, depressing prices for the soybean farmers.At the same time, the price of corn would be expected to rise, perhaps as high as $3 per bushel from a base of $2.27 per bushel. Because of these drastic anticipated changes in corn and soybean prices through implementation of this system, attractive beef prices may not result. Furthermore, the rise in corn grain prices and decline in DDGS prices are the opposite of what is needed for production of inexpensive ethanol from corn grain. These effects may not be observed in practice if land formerly devoted to soybean production could be utilized to grow additional corn.

12592 (DSE—3891-T1) **Production cost analysis of Euphorbia lathyris. Final report.** Mendel, D.A. (SRI International, Menlo Park, CA (USA)). Aug 1979. Contract EG-77-X-01-3891. 32p. Dep. NTIS, PC A03/MF A01.

The purpose of this study is to estimate costs of production for Euphorbia lathyris (hereafter referred to as Euphorbia) in commercial-scale quantities. Selection of five US locations for analysis was based on assumed climatic and cultivation requirements. The five areas are: nonirrigated areas (Southeast Kansas and Central Oklahoma, Northeast Louisiana and Central Mississippi, Southern Illinois), and irrigated areas: (San Joaquin Valley and the Imperial Valley, California and Yuma, Arizona). Cost estimates are tailored to reflect each region's requirements and capabilities. Variable costs for inputs such as cultivation, planting, fertilization, pesticide application, and harvesting include material costs, equipment ownership, operating costs, and labor. Fixed costs include land, management, and transportation of the plant material to a conversion facility. Euphorbia crop production costs, on the average, range between $215 per acre in nonirrigated areas to $500 per acre in irrigated areas. Extraction costs for conversion of Euphorbia plant material to oil are estimated at $33.76 per barrel of oil, assuming a plant capacity of 3000 dry ST/D. Estimated Euphorbia crop production costs are competitive with those of corn. Alfalfa production costs per acre are less than those of Euphorbia in the Kansas/Oklahoma and Southern Illinois site, but greater in the irrigated regions. This disparity is accounted for largely by differences in productivity and irrigation requirements.

12593 (ORO—5912-T1) **Production of sugarcane and tropical grasses as a renewable energy source. Third quarterly report, December 1, 1978-February 28, 1979.** Alexander, A.G.; Allison, W.; Garcia, M. (Puerto Rico Univ., Rio Piedras. Agricultural Experiment Station). 1979. Contract ET-78-S-05-5912. 45p. Dep. NTIS, PC A03/MF A01.

Research continued on candidate screening, water and nitrogen regimes, and ratoon-crop performance for row-spacing, harvest frequency, and varietal variables. Greenhouse tests revealed several grasses having growth and drouth-tolerance characteristics superior to Sordan 70A, the project's outstanding short-rotation candidate up to this time. Johnson grass (Sorghum halepense), regarded as a weed by PR farmers, gave very favorable growth performances under simulated arid and semi-arid conditions. At six months into Year 2, first ratoon data for sugarcane and napier grass indicate yield increases of 33% and 4%, respectively, over plant crop yields. NCo 310 is emerging as the outstanding sugarcane variety tested to date. There are no consistent responses to narrow row spacing. Frequent recutting (at 2-month intervals) is gradually destroying sugarcane but is not appreciably affecting napier grass. Preliminary field-scale operations were begun with performance tests on a Mathews Company rotary scythe.

BIOMEDICAL SCIENCES, APPLIED STUDIES

12594 (UCD—472-125) **Annual report, 1978-1979.** (California Univ., Davis (USA). Radiobiology Lab.). Oct 1979. Contract EY-76-C-03-0472. 260p. Dep. NTIS, PC A12/MF A01.

Research efforts are directed toward contributing pertinent knowledge for safe and effective utilization of energy in our society. Our research program emphasizes research on mechanisms of effects and quantification of possible late effects from low-level exposure to radiation or from other agents by the use of appropriate biologic test systems. Our interest includes the measurement of exposure and dose and delineation of their possible relationships to health consequences, such as tumors and shortening of lifespan. The effects of exposure in sensitive systems, which include the hematopoietic tissues, gonads, bone, lung, thyroid, and liver, are of particular interest. Basic studies on relevant primary metabolic mechanisms are included. The mission of the Laboratory includes, as an important aspect, the definition of sensitive segments of the test population and the more sensitive of tissue systems within individuals. Appropriate utilization of animal models provides a valid basis for extrapolating information derived in the Laboratory toward the goal of achieving more effective protection for man. Studies on mechanisms and assessment of affects employ a multidisciplinary approach and include expertise in molecular biology, biophysics, physiology, cellular biology, immunology, toxicology, oncology, radiologic dosimetry, analytical chemistry, and biochemistry. These studies assist in the evaluation of long-term, low-level effects by use of either simulated or real emissions from single or multiple sources of nuclear or fossil fuel energy-related pollutants.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 12415

RADIATION EFFECTS ON BIOCHEMICALS

IN VITRO

REFER ALSO TO CITATION(S) 12596

IN MICROORGANISMS

REFER ALSO TO CITATION(S) 12561

IN ANIMALS

12595 (UCD—472-125, pp 101-103) **Whole blood technique for the in vitro growth of con-A stimulated colonies.** Dyck, J.; Wilson, F.D.; Shifrine, M.; Knox, S.; Taylor, N.J. Oct 1979.

In Annual report, 1978-1979.

A whole blood technique for the cloning of canine T-lymphocytes in semisolid media is described. By eliminating the routine Ficoll-Paque lymphocyte isolation, this method avoids questions concerning possible growth modulating or selective effects of Ficoll-Paque and more closely approximates the in vivo milieu. Mitogen titration data indicates that a relatively large dose of concanavalin-A is required for whole blood colony formation compared to the standard Ficoll-Paque method.

12596 (UCD—472-125, pp 105) **Effect of chronic low level radiation on lectin-induced lymphocyte transformation.** Shifrine, M.; Taylor, N.J.; Wilson, F.D.; Wiger, N.; DeRock, E.W. Oct 1979.

In Annual report, 1978-1979.

As part of a comprehensive study of the effect of chronic irradiation on leukemogenesis, we have assessed the immune status of dogs subjected to such irradiation. For this purpose, we found that the whole blood lymphocyte stimulation test (WB/LST) was a more sensitive test and required much less blood. Radioresistant populations were observed. PHA-stimulated lymphocytes showed a profound reduction in response whereas the con-A-stimulated lymphocytes did not exhibit any changes. In dogs showing severe aplastic anemia, the con-A-stimulated lymphocytes were also affected. This dichotomy of immunologic response provides a radionale to explain radiation survival of specific individuals.

IN MAN

12597 (UCD—472-125, pp 104) **Use of lectin-induced lymphocyte stimulation as a biodosimeter of radiation damage.** Shifrine, M.; Taylor, N.J.; DeRock, E.W.; Wiger, N.; Wilson, F.D. Oct 1979.

In Annual report, 1978-1979.

The purpose of this study was to determine the feasibility of utilizing an in vitro test to determine whether an individual has suffered radiation damage. It was not our purpose to develop a test capable of detecting low doses but rather to determine possible damage due to a radiation accident at medium to high doses. In a pilot study using the whole blood lymphocyte stimulation test (WB/LST), we pretested six dogs weekly for three weeks. One was sham irradiated and is referred to as the control and one each received an acute whole body dose of 10, 25, 50, 75, or 100 R. The dogs were tested one day post-irradiation and then weekly for 56 days. Our data indicate that, using Con-A and PHA in the WB/LST, a biodosimeter can be developed to determine recovery of lymphocyte function after suspected radiation exposure to confirm accidental radiation and estimate the magnitude of the dose.

RADIATION EFFECTS ON CELLS

REFER ALSO TO CITATION(S) 12605

EXTERNAL SOURCE

REFER ALSO TO CITATION(S) 12353, 12602, 12615, 12619, 12620

12598 (UCD—472-125, pp 98-99) **Inhibition of cell mediated immune responses by copper, ceruloplasmin and oral contraceptives.** Shifrine, M.; Fisher, G.L.; Taylor, N.J.; DeRock, E.W.; Wiger, N.; Wilson, F.D.; Knox, S. Oct 1979.

In Annual report, 1978-1979.

We have shown that free copper inhibited lymphocyte transformation in the whole blood lymphocyte cultures. Ceruloplasmin also inhibited lymphocyte transformation in the above tests as well as another test involving purified protein derivative from Mycobacterium tuberculosis. Women on oral contraceptives have elevated serum copper and ceruloplasmin levels, as do cancer patients. We hypothesize that women on oral contraceptives may have decreased cell mediated immune responses and may thus be at higher risk for cancer induction.

INTERNAL SOURCE

REFER ALSO TO CITATION(S) 12595, 12597, 12613, 12614, 12616, 12617, 12618, 12634

RADIATION EFFECTS ON MICROORGANISMS

REFER ALSO TO CITATION(S) 12583

BASIC STUDIES

REFER ALSO TO CITATION(S) 12142

VACCINE PREPARATION AND OTHER APPLICATIONS

REFER ALSO TO CITATION(S) 11249

RADIATION EFFECTS ON ANIMALS

MAN

REFER ALSO TO CITATION(S) 12146, 12700

12599 (BNL—51066, pp 1-16) **Environmental protection.** Hull, A.P. Oct 1979.

In Safety and Environmental Protection Division. Progress report, January 1, 1976-December 31, 1978.

Environmental Studies and Internal Dosimetry projects include: Environmental Protection; 1977 Environmental Monitoring Report; Sewage Sludge Disposal on the Sanitary Landfill; Radiological Analyses of Marshall Islands Environmental Samples, 1974 to 1976; External Radiation Survey and Dose Predictions for Rongelap, Utirik, Rongerik, Ailuk, and Wotje Atolls; Marshall Islands - Diet and Life Style Study; Dose Reassessment for Populations on Rongelap and Utirik Following Exposure to Fallout from BRAVO Incident (March 1, 1954); Whole Body Counting Results from 1974 to 1979 for Bikini Island Residents; Dietary Radioactivity Intake from Bioassay Data, a Model Applied to ^{137}Cs Intake by Bikini Island Residents; and External Exposure Measurements at Bikini Atoll.

12600 (BNL—51066, pp 39-44) **Mutiple simultaneous event model for radiation carcinogenesis.** Baum, J.W. Oct 1979.

In Safety and Environmental Protection Division. Progress report, January 1, 1976-December 31, 1978.

Theoretical Radiobiology and Risk Estimates includes reports on: Multiple Simultaneous Event Model for Radiation Carcinogenesis; Cancer Risk Estimates and Neutron RBE Based on Human Exposures; A Rationale for Nonlinear Dose Response Functions of Power Greater or Less Than One; and Rationale for One Double Event in Model for Radiation Carcinogenesis.

12601 (BNL—51066, pp 52-53) **Marshall Islands: educational program.** Naidu, J.R. Oct 1979.

In Safety and Environmental Protection Division. Progress report, January 1, 1976-December 31, 1978.

Education and Training projects include: Marshall Islands Educational Program; and BNL Training Programs.

12602 (CONF-781108—, pp 169-192) **Estimation of the amount of exposure to an environmental clastogen using human cytogenetic dosimetry.** Frome, E.L.; DuFrain, R.J. (Oak Ridge Associated Universities, TN). Jul 1979.

From 4. DOE statistical symposium; Albuquerque, NM, USA (1 Nov 1978).

Cytogenetic analysis of human chromosomes for aberrations is used to assess potential health effects of environmental toxicants. In some situations, a dose-response curve can be derived to quantify the relation between the amount of exposure to a specific clastogen and the yield of CAs. A procedure is described that can be used to obtain point and interval estimates of the exposure for an unknown dose. We assume that the dose-response curve is a linear or quadratic polynomial that passes through the origin and that CA yields for both the unknown exposure and the dose-response curve follow the Poisson distribution. Two numerical examples that involve accidental exposure to nuclear radiation are presented to illustrate the methods.

12603 (COO—3377-T1) **New Jersey Radium Research Project: final report.** Sharpe, W.D. (Cabrini Medical Center, New York (USA)). 1979. Contract EY-76-S-02-3377. 33p. Dep. NTIS, PC A03/MF A01.

Cancers among dead New Jersey subjects were almost three times the expected number. Their radiation experience apparently acted as a generalized carcinogen. Conventional clinical, laboratory and roentgenographic tests neither correlated with calculated radiation exposure nor predicted which subjects subsequently developed cancer. More subjects than expected were deaf and enough of the subjects had increased erythrocyte sedimentation rates and decreased alpha-1 serum globulin levels that both hearing tests and tests of immune competence should be undertaken among asymptomatic exposed populations at regular intervals to see whether these may indicate radiation effects prior to a fatal cancer or blood dyscrasia. If pre-terminal radium-226 burdens validly express total irradiation experience, and past exposure to shorter-lived radium-228 (mesothorium) makes it unlikely that this is so, the distribution of radium osteitis among our subjects suggests that anatomically demonstrable radiation injury occurs in the vast majority of subjects with any radium-226 burden that can be measured above background levels after twenty-five years, and in almost half of those exposed whose measured radium-226 burdens are indistinguishable from background levels. Modification of the occupational exposure standard is recommended. (PCS)

12604 (N—79-16541) **Personnel neutron monitoring in space.** Schaefer, H.J. (University of West Florida, Pensacola (USA)). 1 Nov 1978. Contract NAS9-15417. 22p. NTIS, PC A02/MF A01.

A brief review is presented of available information on the galactic neutron spectrum. An examination is made of the difficulties encountered in the determination of the dose equivalent of neutron recoil protons in the presence of a substantially larger background of trapped and star-produced protons as well as other ionizing particles in space.

12605 (NTISUB/E/296—006) **Radiation carcinogenesis and related radiobiology. Special listing.** (National Cancer Inst., Bethesda, MD (USA). International Cancer Research Data Bank). 15 May 1979. 67p. NTIS, PC A04/MF A01.

The SPECIAL LISTING of Current Cancer Research Projects is a publication of the INTERNATIONAL CANCER RESEARCH DATA BANK (ICRDB) Program of the National Cancer Institute. Each LISTING contains descriptions of ongoing projects in one selected cancer research area. The research areas include: Human cancer and exposure to radiation; Experimental radiation carcinogenesis and radiation biology.

12606 (NUREG/CR—1039) **Estimated radiation doses from thorium and daughters contained in thoriated welding electrodes.** McDowell-Boyer, L.M. (Oak Ridge National Lab., TN (USA)). Dec

1979. Contract W-7405-ENG-26. 53p. (ORNL/NUREG/TM--344). Dep. NTIS, PC A04/MF A01.

The collective radiation dose commitment to the general U.S. population estimated for the annual distribution, use, and disposal of one million thoriated welding electrodes was found to range between 7.9 x 10^2 to 6.4 x 10^3 man-rem to the bone (56 to 5.4 x 10^2 man-rem to the whole body). These values represent the potential dose received by the general U.S. population over a 50-year period following exposure during one year.

12607 (UCRL—82679) **Dosimetry of criticality accidents using activations of the blood and hair.** Hankins, D.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1980. Contract W-7405-ENG-48. 5p. (CONF-800304—5). Dep. NTIS, PC A02/MF A01.

From 5. international congress of the International Radiation Protection Association; Jerusalem, Israel (8 Mar 1980).

The evaluation of the dose that a person received in a criticality accident can be difficult. Most accidents have occurred when the person was not wearing nuclear accident dosimetry and since the NRC no longer requires these dosimeters, future dose evaluations may have to be based on body activations and gamma-to-neutron dose ratios. To aid in a dose evaluation we have compiled in a table the results from numerous criticality accident studies using 10 different critical assemblies, each with different neutron leakage spectra. There are several problems involved in applying these results accurately, the most significant problem being the determination of the configuration of the fissile material at the time of the accident. Other problems include a lack of information concerning the location, orientation, and possible shielding between the person and the accident assembly.

VERTEBRATES

12608 (COO—3380-30) **Tumorigenic action of beta, proton, alpha and electron radiation on the rat skin.** Burns, F.J. (New York Univ., NY (USA). Dept. of Environmental Medicine). 1980. Contract EY-76-S-02-3380. 141p. Dep. NTIS, PC A07/MF A01.

Rat skin is utilized as a model system for studying dose and time related aspects of the oncogenic action of ionizing radiation, ultraviolet light and polycyclic aromatic hydrocarbons. Molecular lesions in the DNA of the epidermis, including strand breaks and thymine dimers, are measured and compared to the temporal and dose related aspects of tumor induction. The induction and repair kinetics of molecular lesions are compared to split dose recovery as modified by sensitizers and type of radition of oncogenic damage.

12609 (LBL—10109) **Spermatogonial stem cell renewal following irradiation.** Fabrikant, J.I. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1979. Contract W-7405-ENG-48. 11p. (CONF-790524—13). Dep. NTIS, PC A02/MF A01.

From 6. international congress symposium on radiation research and stem cells; Tokyo, Japan (13 May 1979).

The spermatogonial cell renewal system can maintain function and a steady level of cell population for relatively long periods of continuous low-level irradiation indicating that there does not appear to be a serious accumulation, over many generations, of damage affecting proliferation. Provided the dose-rate is quite low, there is an effective selective removal of damaged cells with almost complete repair of cellular nonlethal damage. At dose-rates greater than 2 rad/day, spermatogonia are very sensitive to radiation death, and the main reason for the low tolerance to continuous stress could, in part, be the limited extent of compensatory mechanisms regulating spermatogonial cell production. However, there is some capacity to change the patterns of cellular proliferation while still remaining under homeostatic control, and this capacity appears to reside in the relatively radioresistant A/sub s/ stem-cell population. Little is known about the extent to which the spermatogonial cell population can repair nonlethal cellular radiation damage accumulated under continuous stress affecting the regenerative capacity of the tissue. After acute exposure, a minimum number of surviving type A/sub s/ stem-cells are required to repopulate the functional seminiferous epithelium, regeneration proceeds along an ordered cell stage sequence, and is dependent on the time required for all stages from type A/sub s/ spermatogonia to mature spermatozoa. Under continuous irradiation, provided the dose-rate is not too high, the repopulating ability of the seminiferous epithelium is maintained, in the presence of injury, due to initial repair and long-term repair of cellular radiation damage. There is evidence for initial repair, since a dose-rate effect exists in type A survival, at low doses. Long-term repair occurs due to differential radiosensitivities of spermatogonia.

12610 (PNL-SA—7502) **Metabolism and biological effects of alpha-emitting radionuclides.** Bair, W.J. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1979. Contract EY-76-C-06-1830. 9p. (CONF-790524—14). Dep. NTIS, PC A02/MF A01.

From 6. international congress symposium on radiation research and stem cells; Tokyo, Japan (13 May 1979).

The emphasis of much of the current and planned research on the toxicity of alpha-emitting radionuclides is directed toward the complexities of actual and potential conditions of occupational environmental exposures of human beings. These, as well as the more limited studies on mechanisms of biological transport and effects, should increase our ability to predict health risks more accurately and to deal more confidently with human exposures, if and when they occur.

12611 (UCD—472-125, pp 72-82) **Radiation leukemogenesis studies.** Stitzel, K.A.; Wilson, F.D.; Shifrine, M.; White, R.G.; Macias, T.; Munn, S.L.; Kroll, M.R.; Aotaki, A. Oct 1979.

In Annual report, 1978-1979.

The results obtained for the ^{60}Co leukemogenesis study through May 31, 1978 are reviewed. During the year 66 animals were added to the study in the three highest dose levels and controls; 25 were sacrificed. Death from radiation-induced thrombocytopenia occurred in one animal exposed at 2.2 R/day to 1054 total R, the lowest dose rate in which an aplastic condition has been seen at this Laboratory. In addition, of the four adult animals placed in the field as a comparison with the ^{60}Co-irradiated animals at Argonne National Laboratory, three died of bone marrow aplasia at doses of 825 to 1002 R given at 11 R/day. This compares well with our weanling results and is much lower than results reported elsewhere. Future work will concentrate on age-related effects and characterization of the aplasia produced.

12612 (UCD—472-125, pp 83-84) **Effects of chronic whole-body gamma irradiation on cell mediated immunity.** Shifrine, M.; Taylor, N.J.; Wilson, F.D.; DeRock, E.W.; Wiger, N. Oct 1979.

In Annual report, 1978-1979.

The whole blood lymphocyte stimulation test has been used to estimate the effects of chronic, whole-body, gamma irradiation in the dog. At lower dose levels, 0.07 and 0.33 R/day to cumulative dose of about 50 and 250 R, there was no change in cell mediated immunity. Dogs at high dose levels were affected. Dogs which succumbed to aplastic anemia at high doses had reduced immunological responses. Dogs which survived these high doses showed a temporary depression. When aplastic anemia was initially noted, there was a differential response to PHA and Con-A stimulation. The response to the former mitogen was profoundly reduced, but Con-A stimulated cells were unaffected, indicative of the development of radioresistant cell lines. As the dogs progressed toward aplastic anemia, all T lympocytes were negatively affected.

12613 (UCD—472-125, pp 106-107) **Canine lymphocyte activating factor (LAF).** Shifrine, M.; Whaley, C.B.; Wilson, F.D.; Taylor, N.J. Oct 1979.

In Annual report, 1978-1979.

The immune response of an animal is the sum of the result of the interaction of various cells mainly through soluble mediators. It is not enough to look at specific cell populations, it is also necessary to study the interactions between purified cell population. The effect of one subpopulation on another is via soluble mediators. We have been studying one (of several) such mediators in its relation to radiation effects on the immune response. Lymphocyte activating factor (LAF) is defined functionally as a potentiator of the response of thymocytes to phytohemagglutinin (PHA) or concanavalin (con-A). It can also elicit response of unstimulated subpopulations separated from the thymus. It is a product of adherent populations, presumably macrophages. It has been shown to be produced by human, rabbit, and mouse cells, but has not been reported in the dog. It also was shown to be present in higher concentrations in irradiated mice than in comparable unirradiated mice. We have shown that LAF is produced by plastic-adherent populations derived from peripheral blood. Currently we are working to determine the lymphocyte subpopulations with which LAF interacts.

12614 (UCD—472-125, pp 108-109) **Autologous transplantation.** Stitzel, K. Oct 1979.

In Annual report, 1978-1979.

As part of the leukemogenesis study, bone marrow transplantation experiments are planned to investigate injury to the marrow stroma exposed to continuous low level gamma radiation and the role this injury plays in the induction of myeloproliferative disorders. The initial studies were designed to perfect the techniques of autologous bone marrow transplantation at Davis.

12615 (UCD—472-125, pp 110-111) **Effect of chronic radiation (^{60}Co) on neutrophilic migration: a possible index of damage.** Wiger, N.; Shifrine, M. Oct 1979.

In Annual report, 1978-1979.

The leukocyte migration inhibition test (LMI) has been used successfully to assess cell mediated immunity (CMI) in humans and small laboratory animals. In the canine, however, there is a poor correlation between the LMI and in vivo CMI as assessed by skin tests and lymphocyte stimulation assays. We have modified the granulocyte isolation technique, and we currently are assessing different methods for the evaluation of leukocyte function.

12616 (UCD—472-125, pp 112-113) **Radiation effects on lymphohematopoietic colonies: existence of subpopulations of lymphocyte progenitors with differing radiosensitivities and evolution of radioresistant subpopulations in response to continuous irradiation in beagles.** Wilson, F.D.; Shifrine, M.; Dyck, J.A.; Whaley, C.B. Oct 1979.

In Annual report, 1978-1979.

In vitro dose-response relationships were studied for x-irradiation in beagles using a methylcellulose culture system which allows for the growth of T-lymphocyte colonies in response to mitogenic stimulation of peripheral blood lymphocyte by PHA and con-A. The best fit for the resultant survival curves was biexponential indicating the existence of subpopulations of T-lymphocyte progenitors with varying degrees of radiosensitivity. Studies performed on blood obtained from beagles receiving continuous irradiation demonstrated an increased survival for the con-A response but not for PHA. These results demonstrate the evolution of radioresistant con-A responsive T-lymphocyte progenitor in response to continuous irradiation and imply that the target cells for PHA and con-A represent distinct subpopulations of T-lymphocytes.

12617 (UCD—472-125, pp 114-116) **In vitro x-irradiation survival study on murine B lymphocyte colony formation following continuous, in vivo gamma irradiation.** Dyck, J.; Wilson, F.D.; Knospe, W.H.; Graham, R.; Hines, D. Oct 1979.

In Annual report, 1978-1979.

The response of B-lymphocyte colony formation to in vitro x-irradiation is reported for chronically γ-irradiated and normal control mice. Overall colony counts were found to be depressed in the in vivo irradiated mice; however, the D37 for in vitro x-irradiation (relative to own controls) for both groups of mice was found to be nearly identical. The murine B-lymphocyte colony technique (CFU-L "B") is described.

12618 (UCD—472-125, pp 117-119) **Formation of lymphocyte colonies in semisolid mixed-lymphoctye cultures.** Wilson, F.D.; Whaley, C.B.; Shifrine, M. Oct 1979.

In Annual report, 1978-1979.

Peripheral blood lymphocytes obtained from humans, dogs and mice formed lymphocyte colonies in agar and methylcellulose cultures in response to allogeneic and xenogeneic (mixed lymphocyte) stimulation. The majority of such colonies were demonstrated to be of T-cell type based on their ability to rosette with sheep red blood cells. In addition to lymphocytes, surface adherent populations of macrophages including multinucleated giant cells were observed in the mixed lymphocyte cultures.

12619 (UCD—472-125, pp 120-122) **Technique for in situ morphologic analysis of colony-forming units (CFU) grown in semisolid media.** Klein, A.K.; Wilson, F.D.; Golde, D.; Hinds, D.; Conard, M.; Gielow, F.I. Oct 1979.

In Annual report, 1978-1979.

A technique for in situ morphologic analysis of mammalian cells derived from blood-forming organs and cultured in semisolid media has been developed. The technique is used to study colony-forming units of the granulocyte-macrophage series (CFU-C) and of the lymphocytic series (CFU-L). In addition, the technique is used to anlyze colonies grown in semisolid media in mixed lymphocyte cultures.

12620 (UCD—472-125, pp 123-126) **Formation of spontaneous hematopoietic colonies in semisolid cultures of lymphocyte enriched fractions of peripheral blood from beagles.** Wilson, F.D.; Whaley, C.B.; Shifrine, M. Oct 1979.

In Annual report, 1978-1979.

The formation of hematopoietic colonies in semisolid cultures derived from lymphocyte enriched fractions of canine peripheral blood is described. Such colonies occurred in the absence of either mitogens or colony stimulating factor. Although the mechanism(s) involved in such colony formation is not known, preliminary results suggest an increased tendency for spontaneous colony formation with age and a possible relationship to low-level irradiation and neoplasia. The observation underlines the importance of doing non-mitogen stimulated control cultures in order to determine the true influence of mitogens or growth factors on colony formation.

12621 (UCD—472-125, pp 127-128) **Purification and properties of superoxide dismutase from Periplaneta americana.** Misra, H.P.; Froman, B. Oct 1979.

In Annual report, 1978-1979.

Soluble extracts of Periplaneta americana have been shown to contain a single, electrophoretically distinct, superoxide dismutase. This enzyme seems to be highly sensitive to cyanide as well as to chloroform-ethanol mixture. The enzyme has been purified to homogeneity and awaits further characterization.

12622 (UCD—472-125, pp 130-141) **Cumulative causes of death in radionuclide-treated beagles.** Chrisp, C.E.; Spangler, W.L.; Pool, R.R.; Book, S.A. Oct 1979.

In Annual report, 1978-1979.

Tables 1 and 2 show causes of death of all ^{90}Sr- and ^{226}Ra-treated dogs, respectively, as of June 30, 1978. The tables do not include biopsy data, contributory causes of death, or other significant lesions found at necropsy. The experimental design of the ^{90}Sr/^{226}Ra study and treatment codes (R - for ^{226}Ra-injected dogs, and D- and S- for ^{90}Sr-fed and -injected dogs, respectively) are presented elsewhere. (PCS)

12623 (UCRL—82501) **Mahalanobis distance and variable selection to optimize dose response.** Moore, D.H. II; Bennett, D.E.; Wyrobek, A.J.; Kranzler, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 May 1979. Contract W-7405-ENG-48. 22p. Dep. NTIS, PC A02/MF A01.

A battery of statistical techniques are combined to improve detection of low-level dose response. First, Mahalanobis distances are used to classify objects as normal or abnormal. Then the proportion classified abnormal is regressed on dose. Finally, a subset of regressor variables is selected which maximizes the slope of the dose response line. Use of the techniques is illustrated by application to mouse sperm damaged by low doses of x-rays.

INVERTEBRATES

REFER ALSO TO CITATION(S) 12621

MAN

REFER ALSO TO CITATION(S) 12513, 12575, 12602

NUCLIDE KINETICS AND TOXICOLOGY

MAN

REFER ALSO TO CITATION(S) 12479, 12504, 12509

12624 (CONF-791077—3) **Plutonium microdistribution in human bone.** Schlenker, R.A.; Oltman, B.G. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 16p. Dep. NTIS, PC A02/MF A01.

From Workshop on measurement and interpretation of actinide accumulation by man; Snowbird, UT, USA (14 Oct 1979).

The amount and location of plutonium in bone from three humans injected during the mid-1940's has been studied by autoradiography and alpha particle spectrometry. Concentrations are similar on endosteal surfaces, Haversian canal surfaces and periosteal surfaces of long bone midshafts 17 months after injection. Endosteal surface concentrations are higher in the axial skeleton than in the appendicular skeleton 15 and 17 months post injection. For dosimetric purposes, volume deposits may be considered to be infinitely thick whereas surface deposits may be considered to have zero thickness. Secondary surface deposits are dosimetrically important, even when the plutonium is almost completely deposited in bone volume.

12625 (DP-MS—79-47) **Population dose from LWR fuel reprocessing.** Schubert, J.F.; Cooper, R.E.; Watts, J.R.; Bailey, C.E. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1979. Contract EY-76-C-09-0001. 33p. (CONF-791103—65). Dep. NTIS, PC A03/MF A01.

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

The inhalation, submersion, and food ingestion dose to the regional and US population are calculated for estimated releases of radionuclides from a hypothetical LWR nuclear fuel reprocessing plant located in southeastern United States. A mathematical transport, diffusion, and deposition model was used to obtain the air concentrations and ground deposition of the various radionuclides emitted to the atmosphere from the reprocessing facility. The global population dose from atmospheric submersion was also calculated for ^{3}H, ^{14}C, and ^{85}Kr. The total exposure to persons living in the region of the plant would be 0.2% of background.

12626 (LA-UR—79-3316) **Studies on health risks to persons exposed to plutonium.** Voelz, G.L.; Stebbings, J.H. Jr.; Healy, J.W.; Hempelmann, L.H. (Los Alamos Scientific Lab., NM (USA); Rochester Univ., NY (USA)). 1979. Contract W-7405-ENG-36. 29p. (CONF-791085—3). Dep. NTIS, PC A03/MF A01.

From Radiation accident preparedness conference; Oak Ridge, TN, USA (19 Oct 1979).

Two studies on Los Alamos workers exposed to plutonium have shown no increase in cancers of the lung, bone, and liver, three principal cancers of interest following plutonium deposition. A clinical study of 26 workers exposed 32 years ago shows no cases of cancer other than two skin cancers that were excised successfully. A mortality study of 224 workers, all persons with estimated deposition of 10 nCi or moe in 1974, showed no excess of mortality due to any cause. No bone or liver cancers were present, while one death due to

lung cancer was observed as compared to an expected three cases. These negative findings on such small groups are not able to prove or disprove the validity of commonly used risk estimates as recommended in the 1972 BEIR and 1977 UNSCEAR reports, but the data do indicate that much higher risk estimates are not warranted.

12627 Distribution of nitrogen-13 from labeled nitrate ($^{13}NO_3^-$) in humans and rats. Witter, J.P.; Gatley, S.J.; Balish, E. (Univ. of Wisconsin Medical School, Madison). *Science;* **204**: 411-413(27 Apr 1979).

The body distribution of gavaged or intravenously administered nitrate labeled with nitrogen-13 was studied in humans and rats with the following results: (1) the labeled compound is not quickly absorbed from the stomach; (2) the concentration of the label increases inside the lower intestinal tract (cecum and large intestine) when ingested or intravenously injected; and (3) humans and rats have the capacity to store a portion of the label in their bodies. These observations indicate that depletion of body stores, the passage of nitrate down the gut, or the secretion of nitrate into the intestinal lumen may be a better explanation of the urinary, ileal, and fecal concentrations of nitrate and nitrate recently measured in humans than a bacterial nitrification reaction in the intestines, as suggested by Tannenbaum, et al.

12628 Technetium sources and behavior in the environment. Wildung, R.E.; McFadden, K.M.; Garland, T.R. (Battelle Pacific Northwest Lab., Richland, WA). Contract EY-76-C-06-1830. *J. Environ. Qual.;* **8**: No. 2, 156-161(Apr 1979).

Technetium (Tc) may enter the environment as a result of nuclear weapons testing, nuclear power production, nuclear fuel reprocessing, nuclear waste storage, and pharmaceutical use. On the basis of this current knowledge, the behavior and implications of Tc in the environment are assessed and avenues of research are suggested. The most stable chemical species of Tc in aqueous solution is the pertechnetate ion, TcO_4^-. As the pertechnetate ion, Tc is highly soluble in water and in soil, but reduced forms (dioxide and sulfide) have limited solubility; sorption is significant in surface soils of high organic C content and low pH and may be significant in subsoils and geologic media under reduced conditions. A fraction of the sorption measured in surface soils may also have been due to immobilization in microbial cells. The pertechnetate ion is readily available to microbiota, algae, and higher plants and is toxic to higher plants at relatively low soil levels (0.1 μg/g). In higher plants, it is transported largely as the pertechnetate ion and toxicity appears to be due to biochemical rather than radiation effects. Uptake and toxicity appear to be due to Tc functioning as a nutrient analog. Preliminary studies indicate that, in contrast to hydrolyzable radionuclides, incorporation of Tc in plants reduces Tc absorption in animals. Ultimately, the mobility and availability of Tc to biota will be governed by the quantity and form emitted and its form and solubility over the long-term in soils, sediments, and waters. Uptake by biota will be dependent upon the rate and extent of Tc movement across biological membranes and its toxicity. Proper evaluation of these phenomena will be largely dependent on development of an understanding of Tc sorption mechanisms in soils and sediments and the determination of the stable forms of soluble chemical species that occur in the environment over the long term.

ANIMALS

REFER ALSO TO CITATION(S) 12513, 12574, 12575, 12610, 12622, 12627

12629 (LA-UR—79-3378) **Pulmonary carcinogenesis from plutonium-containing particles.** Thomas, R.G.; Smith, D.M.; Anderson, E.C. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 5p. (CONF-800304—9). Dep. NTIS, PC A02/MF A01.

From 5. international congress of the International Radiation Protection Association; Jerusalem, Israel (8 Mar 1980).

Plutonium administered as an alpha radiation source to the respiratory tracts of Syrian hamsters has resulted in various incidences of neoplasia. Adenomas are the primary lung tumor observed, but adenocarcinomas are also prevalent.

12630 (UCD—472-125, pp 142-148) **Comparison of effects in beagles from injected ^{226}Ra and ingested ^{90}Sr.** Raabe, O.G.; Parks, N.J.; Chrisp, C.E.; Book, S.A.; Goldman, M. Oct 1979.

In Annual report, 1978-1979.

Beagles injected with ^{226}Ra or fed ^{90}Sr have been under lifetime study during the past 17 years. This report summarizes the dose-response observations to June 30, 1978 based upon average dose rate (rad/day) to the skeleton from initiation of exposure to death. Comparison of the dose-response functions describing bone tumors showed an apparent reduction in relative biological effectiveness (RBE) from 1.5 to 0.05 for ^{90}Sr-Y average dose rates from 16 rads/day to 1.6 rads/day compared to radiation exposure from ^{226}Ra (and associated radon and progeny) in bone. Continued study of the 335 living dogs remaining in this bone-seeking radionuclide project will provide valuable information concerning the effects from ^{90}Sr and ^{226}Ra for dose rates below 1.6 rads/day. Results to date indicate that although bone cancer continues to be the important endpoint for ^{226}Ra, other cancer types may be more important for ^{90}Sr (such as soft tissue cancers adjacent to bone), particularly at lower dose rates.

12631 (UCD—472-125, pp 149-153) **Effects of continuous irradiation by ^{226}Ra and ^{90}Sr on hematopoiesis.** Wilson, F.D.; Munn, S.; Stitzel, K. Oct 1979.

In Annual report, 1978-1979.

The effects of continuous radiation on hematopoiesis by the internal emitters ^{226}Ra and ^{90}Sr were examined. The effect on granulopoiesis appeared most profound. Extensive effects on blood platelets were observed with ^{90}Sr, but not with ^{226}Ra. Neither radionuclide at the dose levels utilized resulted in compromised erythropoiesis. The changes occurred in the absence of any significant radiation dose to extramedullary sites. The results are discussed with respect to known mechanisms of hematopoiesis.

12632 (UCD—472-125, pp 154-164) **Lifespan dynamics of intraskeletal radionuclide distribution in radium-injected beagles.** Parks, N.J. Oct 1979.

In Annual report, 1978-1979.

The distribution of ^{226}Ra activity among the bone groups of the skeleton has been measured as a function of time after exposure for 12 beagles. The dogs were given 8 semimonthly injections of radium totalling 0.37 μCi/kg, 1.11 μCi/kg, or 3.33 μCi/kg between the ages of 435 and 535 days. Most of the bone groups were found to lose activity at approximately the same rate as the whole skeleton. By consideration of a partitioned clearance model, the whole-body retention function characteristic of beagles exposed to radium levels < 3.33 μCi/kg is partitioned into two functions representative of cancellous and compact bone. The relative radioactivity concentrations predicted by the model are in agreement with available data. Comparison of site-specific tumor-incidence for these beagles revealed an apparent 70-fold variation of dose-response among the bone groups studied.

12633 (UCD—472-125, pp 170-173) **Iodine-129: chronic exposure in rats.** Book, S.A.; McNeill, D.A. Oct 1979.

In Annual report, 1978-1979.

In response to the need for information on the risks associated with the handling and storage or disposal of radioactive wastes, we are investigating the biologic significance of iodine-129, a potentially hazardous, very long-lived radionuclide. We are evaluating the effects of long-term, low level radiation exposure relative to thyroid tumorigenesis and life shortening. Sixty rats have been introduced into a study in which they will receive lifetime exposures to high levels of ^{129}I. An additional 60 control animals are receiving ^{127}I in quantities equivalent to the ^{129}I diet in terms of elemental iodine. Although the experimental rats are maintaining a relatively high thyroidal ^{129}I burden, no ill effects have been observed.

12634 (UCD—472-125, pp 174-183) **Comparative effectiveness of ^{132}I and ^{131}I in the rat thyroid gland.** Book, S.A.; McNeill, D.A.; Parks, N.J.; Spangler, W.L. Oct 1979.

In Annual report, 1978-1979.

The thyroidal effects of short-lived radioiodines such as ^{132}I, ^{133}I, and ^{135}I have not been well defined. Instead, their effects have been assumed to be similar to those obtained by external x-ray exposure, or about 10 times as effective as the longer-lived and better understood radioiodine, ^{131}I. We report here the results of a study done to compare the effects of ^{132}I and ^{131}I and to confirm the suitability of the assumed 10-fold difference. We found the same effect in goitrogen-stimulated rat thyroid glands (in terms of 50% suppression of thyroid gland weight increase) at injected dosages of 94 μCi ^{132}I and 13 μCi ^{131}I. Doses, however, were 1.7 rads/μCi ^{132}I and 175 rads/μCi ^{131}I. The same 50% suppression for thyroid dose was found to occur at about 160 rads from ^{132}I and 2200 rads from ^{131}I, suggesting an approximately 14-fold increase in radiologic effectiveness of ^{132}I over ^{131}I.

12635 (UCD—472-125, pp 184-192) **Effects of ^{131}I on thyroid glands of guinea pigs of different ages.** Book, S.A.; McNeill, D.A.; Spangler, W.L. Oct 1979.

In Annual report, 1978-1979.

In view of the limited data on age-related radiosensitivity of the thyroid gland to radioiodine exposure, and because of a need for this information, we injected fetal, neonatal, weanling, and adult guinea pigs with single, graded dosages of iodine-131. Dosages were 0 to 100 μCi ^{131}I and resulted in thyroid doses ranging from hundreds to tens of thousands of rads. Subsequent testing of the animals' thyroid glands, in terms of function and size, yielded this order of radiosensitivity: weanling > fetus > neonate > adult. The differences, with regard to effects per rad, did not appear to exceed a factor of 6 between the most and least radiosensitive age-groups.

12636 (UCD—472-125, pp 193-199) **Predictive model of pulmonary toxicity from inhaled plutonium oxide aerosols.** Raabe, O.G.; Goldman, M. Oct 1979.

In Annual report, 1978-1979.

The potential toxicity of plutonium in people must be estimated using animal expermental data. Inhalation studies conducted at Battelle-Northwest Laboratory have been reviewed, and beagle mortality data to 1000 days after esposure to aerosols containing ^{238}Pu and ^{239}Pu were compared to the parallel data from Lovelace Foundation involving aerosols with ^{90}Sr-Y and ^{144}Ce-Pr. A simple model was developed showing a nearly identical dose-response relationship displaced by a characyeristic RBE for each aerosol type. The results include a predictive model of both time to death and dose-response probability at given exposure levels and times post-exposure. In addition, this model provides new insights into appropriate radiobiological principles describing acute pulmonary injury.

12637 (UCD—472-125, pp 200-231) **Comparative toxicity of strontium-90 and radium-226 experimental design and current status.** Book, S.A.; Chrisp, C.E.; Goldman, M. Oct 1979.

In Annual report, 1978-1979.

This study of the biologic effects of ^{90}Sr and ^{226}Ra on the beagle dog has, as its primary goal, the determination of possible long-term hazards to man from chronic exposure to low levels of irradiation. Animals received graded dosages of either radionuclide by several means of administration: continual ingestion of ^{90}Sr, a single intravenous injection of ^{90}Sr, or a series of eight intravenous injections of ^{226}Ra. The administration of ^{90}Sr and ^{226}Ra ended at 540 days of age; the animals are receiving chronic, low level radiation doses from these important bone-seeking radionuclides, and the significance of these low doses given at low dose rates is being investigated with regard to cancer production, physiological well-being, and shortening of life.

PLANTS

REFER ALSO TO CITATION(S) 12533

12638 **Americium-241 uptake by Bahiagrass as influenced by soil type, lime, and organic matter.** Hoyt, G.D.; Adriano, D.C. (Savannah River Ecology Lab., Aiken, SC). Contract EY-76-C-09-0819. *J. Environ. Qual.;* **8**: No. 3, 392-396(Jul 1979).

Availability of ^{241}Am to bahiagrass (Paspalum notatum), a major forage crop in the southeastern US, was studied under greenhouse conditions using two soil types, two rates of lime, and four rates of organic matter. The plants were grown in pots until three clippings were obtained. Americium-241 concentrations in plant tissues from the unlimed Dothan (24% clay) soil were, on the average, approximately twice as high as those from unlimed Troup (10% clay) soil. Lime significantly reduced ^{241}Am uptake from both soils. The americium concentration ratios (americium concentration in dry plant tissue/average americium concentration in dry soil) for limed treatments were, in general, one order of magnitude lower than those for unlimed treatments. Organic matter, added to the soils as bermuda grass hay, somewhat reduced ^{241}Am uptake, especially when added at high rates in unlimed soils. The effect of lime on uptake could be attributed to immobilization of americium ions external to the roots as a result of decreased solubility of this radionuclide and/or antagonistic effect of increased calcium ion concentration in the soil solution on americium ions. The effect of organic matter on uptake could be attributed to its fixing capacity for metals.

THERMAL EFFECTS

MICROORGANISMS

REFER ALSO TO CITATION(S) 11911

INVERTEBRATES

12639 (PB—290596) **Responses of selected Chesapeake Bay fish and invertebrate species to natural and artificial thermal increases - a review of the literature.** Liden, L.H.; Burton, D.T. (Academy of Natural Sciences of Philadelphia, Benedict, MD (USA). Benedict Estuarine Research Lab.). 1978. 64p. NTIS, PC A04/MF A01.

A review of the biological literature concerning the acute effects of thermal increases upon several fish and invertebrate species indigenous to the Chesapeake Bay was conducted. The acute effects data were combined with other natural life-temperature interaction data for developmental stages of Pseudopleuronectes americanus, Morone saxatalis, Leiostomus xanthurus, Micropogon undulatus, Menidia menidia, Anchoa mitchilli, Brevoortia tyrannus and Crassostrea virginica and Callinectes sapidus. The data were evaluated to ascertain what effects, if any, the thermal discharge (5.6C maximum delta T) from Calvert Cliffs Nuclear Power Plant would have upon populations of these species in the Chesapeake Bay. It was concluded from the data that a thermal discharge such as that from Calvert Cliffs would have little or no impact upon the egg, larval, juvenile or adult populations of the studied species.

VERTEBRATES

REFER ALSO TO CITATION(S) 12129, 12130, 12639

CHEMICALS METABOLISM AND TOXICITY

REFER ALSO TO CITATION(S) 11082, 12415

CELLS

REFER ALSO TO CITATION(S) 12583, 12598

12640 (LBL—10096) **Interaction of benzo[a]pyrene-7,8-dihydrodiol-9,10-oxide with simian virus 40 DNA and chromatin.** Gamper, H.B. Jr. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 174p. Dep. NTIS, PC A08/MF A01.

Thesis.

In mammalian cells, benzo[a]pyrene undergoes metabolic activation to the ultimate carcinogen benzo[a]pyrene-7,8-dihydrodiol-9,10-oxide (BaP diol epoxide). The conformation of simian virus 40 (SV40) DNA and chromatin reacted in vitro with BaP diol epoxide was studied. Nicking of superhelical SV40 DNA was monitored. Approximately 1% of the initial BaP diol epoxide alkylation sites rearranged with strand scission at pH 8.0. This strand scission was due to one or more minor alkylation products. The kinetics of nicking were characteristic of a multistep rearrangement terminating in strand scission. No evidence was obtained for nicking proceeding through a phosphotriester mechanism. The superhelical density of BaP diol epoxide modified superhelical and partially relaxed SV40 DNA was determined and an unwinding angle for the hydrocarbon guanine adduct was calculated. The anlge was dependent upon the torsional strain of the molecule. This data indicated that the modified G-C base pair was disrupted. In the absence of such strain the alkylation sites had an ordered structure with the hydrocarbon oriented in the minor or major groove of the helix. Although BaP diol epoxide adducts were externally bound, the hydrocarbon appeared to intercalate prior to reaction with the exocyclic amino group of guanine. Thus, covalent binding was modulated by helix stability. Counterions inhibited alkylation by up to 90%, Mg^{2+} being more effective than Na^{+}, and superhelical SV40 DNA more susceptible than partially relaxed viral DNA. The alkylation of SV40 minichromosomes was also investigated. Relative to protein-free SV40 DNA, minichromosomal DNA was 1.5X less susceptible to alkylation but 2X more prone to strand scission. The alkylation of minichromosomal DNA was random. (ERB)

12641 (UCD—472-125, pp 40-43) **Biochemical studies of pulmonary alveolar macrophages.** Misra, H.P.; Fisher, G.L.; Fong, J.; Valentine, R. Oct 1979.

In Annual report, 1978-1979.

Pulmonary alveolar macrophages were collected and purified for measurement of biochemical functions including mixed function oxidase, superoxide production, lipid peroxidation and release of a proteolytic enzyme, elastase. Sensitive techniques are being developed to determine these biochemical characteristics of alveolar macrophage after exposure to particulate effluents from coal combustion.

12642 (UCD—472-125, pp 51-52) **Studies on in vitro dose-response characteristics of trace elements (Zn, Se) on lymphohematopoietic progenitors using semisolid culture systems.** Wilson, F.D.; Concoby, B.A.; Fisher, G.L. Oct 1979.

In Annual report, 1978-1979.

Using techniques allowing for the cloning of lymphohematopoietic stem and progenitor cells that have previously been used for radiation effects studies, the authors demonstrated the feasibility of their use as a sensitive short-term bioassay to determine the effects of fossil fuel combustion products on cellular pathways involved in hematopoiesis and immunological processes. (PCS)

12643 (UCD—472-125, pp 53-55) **Morphometric studies of pulmonary alveolar macrophages.** Finch, G.L.; Hayes, T.L.; Fisher, G.L. Oct 1979.

In Annual report, 1978-1979.

To evaluate further the potential health hazards of coal combustion products, detailed morphological and morphometric studies of pulmonary alveolar macrophages (PAM) have been initiated. These scanning electron microscopy (SEM) studies are complementary to our efforts to characterize the PAM as sensitive indicators of pulmonary exposure to coal fly ash. This report describes our

recent efforts to provide a reproducible fixation technique to allow quantitation of morphological properties of PAM.

12644 (UCD—472-125, pp 56-58) **Effects of sera on the in vitro function of pulmonary alveolar macrophage.** Fisher, G.L.; McNeill, K.L. Oct 1979.

In Annual report, 1978-1979.

Quantification of pulmonary alveolar macrophage function in vitro requires detailed description of factors affecting the reproducibility and sensitivity of assay systems. This report demonstrates the importance of serum and possibly, associated zinc, as a mediator of in vitro macrophage function.

12645 (UCD—472-125, pp 86) **Suspension culture of macrophages: an in vitro source of purified mononuclear phagocytes and progenitors.** Buhles, W.C.; Shifrine, M. Oct 1979.

In Annual report, 1978-1979.

Mouse bone marrow cells were cultured in suspension in polypropylene tubes containing tissue culture media supplemented with a source of hematopoietic colony-stimulating factor. It is suggested that this culture technique may serve as a source of naive macrophages which are not exposed to lymphokines, undefined and possibly cross-reacting antigens, or other inflammatory mediators present in vivo which may alter macrophage functions. (PCS)

12646 (UCD—472-125, pp 100) **Effect of copper on lectin-induced lymphocyte proliferation.** Shifrine, M.; Taylor, N.J.; DeRock, E.W.; Wiger, N,; Fisher, G.L. Oct 1979.

In Annual report, 1978-1979.

To measure the effect of copper on the immune response, we used the whole blood lymphocyte stimulation test (WB/LST) which is an in vitro corollary of in vivo cell mediated immunity, as well as the mixed lymphocyte culture (MLC). Copper was found to inhibit lymphocyte division at doses of about 1 μg per 10^6 lymphocytes (50% inhibition) depending on the test used. Total inhibition of lymphocyte blastogenesis was seen with about 10 μg per 10^6 lymphocytes.

MICROORGANISMS

REFER ALSO TO CITATION(S) 12525, 12533

12647 (CONF-791002—4) **Interlaboratory comparison of mutagenesis testing of coal fly ash derived from different coal conversion technologies.** Chrisp, C.; Hobbs, C.; Clark, R.; Kubitschek, H.E. (Argonne National Lab., IL (USA); California Univ., Davis (USA). Radiobiology Lab.; Lovelace Foundation for Medical Education and Research, Albuquerque, NM (USA). Inhalation Toxicology Research Inst.). 1979. Contract W-31-109-ENG-38. 38p. Dep. NTIS, PC A03/MF A01.

From 19. annual Hanford life sciences symposium; Richland, WA, USA (22 Oct 1979).

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This experiment showed that mutagenicity of fly ash derived from different coal conversion technologies, as determined by the Ames plate incorporation test, was similar in all three laboratories. The differences in mutagenic activity of each fly ash between laboratories with different solvent extraction methods were no greater than one order of magnitude. In addition, there were much smaller, but still significant differences in mutagenic activity between laboratories when the same solvent extract of a particular fly ash was tested in each laboratory. There were also significant differences in mutagenicity of the positive control mutagen (maximum of fivefold) between laboratories. Because of this difference in Ames test sensitivity between laboratories, the influence of the solvent extraction methods on differences in mutagenicity was not clear. However, the data suggested that either there were significant differences in the degree of sensitivity of Ames tests for different complex mixtures within each laboratory, or else there were differences in mutagen extraction efficiency between different solvent extraction methods. Both Ames test sensitivity and solvent extraction may be important. Further work would be necessary to separate the contribution of these two factors. An important aspect of further work would be to separate the contribution of the innate sensitivity of substrains of Ames tester strains in each laboratory from the possible effects of differences in Ames testing methodology. This could be done by testing the same extracts of fly ash and positive control mutagens with substrains of tester strains exchanged between laboratories. This work also implies that caution should be exercised in assuming that the same solvent would have the same efficiency for extraction of mutagens from different fly ashes even within the same laboratory.

12648 (UCD—472-125, pp 44-47) **Analysis of variation in Ames testing of coal fly ash.** Lammert, J.; Chrisp, C.E. Oct 1979.

In Annual report, 1978-1979.

The Ames pour plate test was designed to be a qualitative test for the detection of mutagens. The degree of variation between different solvents, different batches of horse sera, and metabolic activation is discussed. Variation of results between test days was shown to be important.

12649 (UCD—472-125, pp 48-50) **Physical factors affecting the mutagenicity of coal fly ash.** Fisher, G.L.; Chrisp, C.E.; Raabe, O.G. Oct 1979.

In Annual report, 1978-1979.

The finest, most respirable fly ash fractions collected from the smokestack of a power plant were the most mutagenic for histidine-requiring auxotrophs of Salmonella typhimurium. Plant electrostatic precipitator ash samples were not mutagenic. The mutagens in coal fly ash were resistant to x-ray or ultraviolet irradiation, possibly due to stabilization by fly ash surfaces. Heating experiments indicated that all mutagenic activity is lost with heating to 350°C.

12650 **Toxaphene, a complex mixture of polychloroterpenes and a major insecticide, is mutagenic.** Hooper, N.K.; Ames, B.N.; Saleh, M.A.; Casida, J.E. (Univ. of California, Berkeley). Contract EY-76-S-03-0034-PA156. *Science;* **205**: 591-593(10 Aug 1979).

Toxaphene, the most widely used chlorinated insecticide, is mutagenic in the Salmonella test without requiring liver homogenate for activity. This insecticide is a complex mixture (more than 177 polychloroterpenes) with carcinogenic activity in rodents. Some but not all of the mutagenic components are easily separated from the insecticidal ingredients.

PLANTS

REFER ALSO TO CITATION(S) 12498

12651 (AD-A—065563) **The effects of designated pollutants on plants. Annual report no. 3, 1 jul 77-30 jun 78.** Granett, A.L.; Taylor, O.C. (California Univ., Irvine (USA)). Nov 1978. Contract F33615-76-C-5005. 74p. NTIS, PC A04/MF A01.

The phytotoxicity of hydrogen chloride (HCl) gas and aluminum oxide (Al_2O_3) particulates was studied in special plant exposure chambers. These pollutants were generated separately by diluting bottled gas or commercial alumina dust. In addition, generation was affected by open-burning of small pieces of solid rocket fuel. The characteristics of these burn products were investigated. Rocket fuel gases produced phytotoxic responses similar to that seen on plants exposed to commercial HCl gas.

12652 (PB—290357) **The effects of present and potential air pollution on important San Joaquin Valley crops: sugar beets. Final report.** Brewer, R.F. (California Univ., Riverside (USA). Dept. of Botany and Plant Sciences). May 1978. Contract ARB-A6-161-30. 45p. NTIS, PC A03/MF A01.

The objectives of this study were: (1) to determine whether sugar beets are being damaged by current levels of ozone, (2) to establish several points on the ozone dose response curve for sugar beets and (3) to compare the performance of open top growth chambers with conventional closed top greenhouse type chambers. Sugar beets were grown at Parlier, CA in chambers supplied with air containing varying proportions of existing pollutants achieved by filtering all, none or part of the air with activated carbon. Two types of chambers were used in the study, one a conventional greenhouse with plastic covered sides and top, and a second experimental unit with plastic walls and open top. Both types covered an area 12 feet square and were ventilated with continuously running motor driven blowers. The conclusion was that sugar beets are not now being significantly damaged by prevailing oxidant air pollution in the central San Joaquin Valley.

12653 (PB—291734) **Effects of sulfuric acid aerosols on vegetation.** Lang, D.S. (Minnesota Univ., St. Paul (USA). Dept. of Plant Pathology). Jan 1979. 98p. NTIS, PC A05/MF A01.

A continuous flow system for exposing plants to submicron aerosols of sulfuric acid has been developed and an operational model has been constructed. Exposure chambers have been designed to allow simultaneous exposures of the same plant to aerosol and control environments. All surfaces within the exposure system are composed of either Teflon or stainless steel to minimize corrosion. Submicron acid aerosols are mechanically generated and are distributed in size representative of resident particulates found in the atmosphere. Plants have been found to be injured by exposures to high concentrations of sulfuric acid aerosol (100-200 mg/cum) for short times of 4-16 hours. Injury to vegetation caused by sulfuric acid aerosol is similar to that caused by gaseous fluoride and is characterized by marginal and tip necrosis of foliage. Different plant species vary greatly in sensitivity to sulfuric acid aerosol and injury to sensitive species appears to be conditioned by biological as well as physical factors.

12654 **Concentrations of coumestrol and 4',7-dihydroxyflavone in four alfalfa cultivars after exposure to ozone.** Skaerby, L.; Pell, E.J. (Pennsylvania State Univ., University Park). *J. Environ. Qual.;* **8**: No. 3, 285-286(Jul 1979).

Ozone can induce increases of 4',7-dihydroxyflavone (4',7-DHF) but not coumestrol in the Buffalo alfalfa cultivar. This study was designed to determine whether these responses were unique to Buffalo or characteristic of other alfalfa cultivars. Seven-week-old seedlings of Ladak, Sonora, Moapa, and Vernal alfalfa cultivars were exposed to 773 $\mu g/m^3$ (0.40 ppM) ozone for 3 hours. Forty-eight hours after exposure, all foliage exhibiting chlorosis to extensive necrosis were harvested. Similar-aged foliage from non-ozonized control plants was also harvested. Methanolic extracts of the tissue were prepared and the presence and quantity of coumestrol and 4',7-DHF determined. Coumestrol was not detected in control or ozonized tissue. Nonozonized tissue was free of detectable 4',7-DHF. Injured foliage of all four cultivars contained elevated levels of 4',7-DHF as high as 91 ppM. There were no significant differences in concentrations of 4',7-DHF when concentrations were compared in four ozonized cultivars.

INVERTEBRATES

REFER ALSO TO CITATION(S) 11422, 12682

12655 (COO—2546-4) **Effects of drilling muds on lobster behavior. Progress report, 1 January-1 October 1979.** Atema, J.; Ashkenas, L.; Beale, E. (Boston Univ., Woods Hole, MA (USA). Marine Biological Lab.). 1979. Contract EY-76-S-02-2546. 107p. Dep. NTIS, PC A06/MF A01.

Drilling muds, used and discarded in great quantities during the drilling phase of exploration and production of oil wells, represent an unknown threat to the marine environment. The compositions of the muds vary greatly with drilling requirements. The toxicity of their components are largely unknown, but can range from apparently harmless to immediately lethal, as found recently in toxicity tests on a number of marine animals. This report contains eight sections, each describing an aspect of studies of lobster behavior, ecology, physiology and the effects of exposure to various levels of different drilling muds.

VERTEBRATES

REFER ALSO TO CITATION(S) 11422, 12575, 12608, 12644

12656 (BNL—50964) **Trifluoroethanol.** Silberstein, S. (Brookhaven National Lab., Upton, NY (USA)). Oct 1978. Contract EY-76-C-02-0016. 20p. Dep. NTIS, PC A02/MF A01.

Fluorinol-50 and -85 (containing 50 and 85 mole % trifluoroethanol (TFE), respectively) are candidate working fluids for truck and power plant Diesel bottoming cycles, respectively. TFE is self-extinguishing and chemically stable at its proposed operating temperature. Toxic effects were not seen in production workers at Halocarbon Products Corp., the manufacturer, but are apparent in animal studies. The most obvious effects upon acute or chronic inhalation exposure are intoxication, narcosis, and death, but there is wide disagreement on concentrations producing nervous system effects. Ethanol is an antidote. Sterility and impaired spermatogenesis were first noted at 50 ppM in male rats. These changes may be reversible. Exposure of female rats to 10 ppM produced enlarged ovaries. Functional tests of reproductive ability were not done, but they should be, since the above concentrations are not much higher than the recommended threshold limit value, 2.5 ppM. Skin contact with TFE can cause nervous system effects and even death; eye contact produces corneal opacity. Because of TFE's ability to penetrate intact skin, the Toxic Materials Advisory Committee of the US Department of Energy strongly recommended that a less toxic working fluid be sought. We fully concur. It is unknown whether TFE will add to the danger of truck accidents, but leakage of the small amount of TFE used probably will not contaminate drinking water.

12657 (CONF-791002—3) **Effect of reaerosolized fly ash from an atmospheric fluidized bed combustor on murine alveolar macrophages.** Brennan, P.C.; Kirchner, F.R.; Norris, W.P. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 18p. Dep. NTIS, PC A02/MF A01.

From 19. annual Hanford life sciences symposium; Richland, WA, USA (22 Oct 1979).

Male $B6CF_1$ mice were exposed to reaerosolized fly ash. The fly ash was collected from the final filter of an atmospheric pressure fluidized-bed coal combustor and reaerosolized from a liquid nitrogen suspension. In four short experiments, (30-36 hrs; 6 hrs/day for 5-6 days) the fly ash was a composite of both start-up and steady-state material. In another experiment of longer duration (100 hrs; 6 hrs/day over a 4-week period), the fly ash used consisted of material from only steady-state operation of the combustor. Fly ash collected during steady-state operation is about 10 times less mutagenic in the Ames Salmonella test than is fly ash collected during start-up operation of the combustor. Mice exposed to fly ash in the short experiments showed a 2 to 4 fold increase in the number of alveolar macrophages 4 days after exposure and these macrophages were full of engulfed particles when examined by light microscopy. In in vitro tests 4-26 days after this exposure, macrophages from mice were unable to kill a challenge dose of Staphylococcus aureus as effectively as those from control mice. There was impairment in both phagocytic ability and in intracellular killing. Macrophages from mice exposed for 100 hrs to fly ash collected during steady-state operation were similarly full of engulfed particles when examined 4 days after exposure. However, the ability of these macrophages to kill S. aureus was unimpaired at this time and six months after exposure. These early observations suggest that the presence of mutagenic material on fly ash impairs the ability of macrophages to phagocytize and kill a challenge dose of S. aureus.

12658 (ORNL/TIRC—78/4) **LEPTOPHOS: an overview. Literature compilation, 1969-1979.** Waters, E.M.; Gerstner, H.B. (Toxicology Information Response Center, Oak Ridge, TN (USA)). Dec 1979. Contract W-7405-ENG-26. 94p. Dep. NTIS, PC E08/MF E08.

The physical and chemical properties of leptophos, the use and mode of action in target species, and the metabolism and toxicology in vertebrates are discussed. (PCS)

12659 (UCD—472-125, pp 2-8) **Generation of fly ash aerosols for exposure of rats and monkeys.** Raabe, O.G.; McFarland, K.D.; Tarkington, B.K. Oct 1979.

In Annual report, 1978-1979.

Techniques have been developed for the laboratroy generation of aerosols of power plant fly ash from coal-burning power plants. Size-classified fly ash particles smaller than 5 μm in aerodynamic diameter were dispersed with a Wright dust feed mechanism in combination with a cyclone separator and ^{85}Kr discharger. During a 180-day exposure period, aerosols with mass concentration averaging 4.2 mg/cm^3 were generated into a 3.5 m^3 exposure chamber suitable for exposure of rodents or nonhuman primates. Aerodynamic size distributions determined with a cascade impactor had an average mass median aerodynamic diameter of 1.98 μm (0.02 μm SE), with an average geometric standard deviation of 1.65 (0.02 SE).

12660 (UCD—472-125, pp 59-61) **Comparative nasopharyngeal anatomy for aerosol inhalation deposition evaluation.** Schreider, J.P.; Raabe, O.G. Oct 1979.

In Annual report, 1978-1979.

Silicone rubber corrosion casts were prepared from the respiratory tracts of beagle dogs, rats, and a rhesus monkey. Special attention was paid to the morphometry of the nasal regions of these animals. The morphometry of the nasal regions of these species is compared and contrasted with respect to the effects of nasal deposition of airborne particles.

12661 (UCD—472-125, pp 62-64) **Quantification of inhaled fly ash in rat lungs.** Silberman, D.; Fisher, G.L.; Raabe, O.G.; Last, J.A. Oct 1979.

In Annual report, 1978-1979.

A technique is described for the quantification of inhaled fly ash. After lung burdens of chronic inhalation of laboratory-generated fly ash aerosols for up to 90 days, the aluminum content of rat lung was determined by atomic absorption spectrophotometry. Calculation of deposition fractions for inhaled fly ash based on fly ash burdens calculated from aluminum analysis were in agreement with expected values.

12662 (UCD—472-125, pp 65-69) **Effects of acute inhalation of fly ash and silica to C57BL/6 male mice.** Fisher, G.L.; Wilson, F.D.; Bradley, E.W. Oct 1979.

In Annual report, 1978-1979.

Studies were performed to evaluate the effects of fly ash and silica inhalation exposures on macrophage function and progenitors. Mice, C57BL/6, were acutely exposed to fly ash or silica aerosols and sacrificed 2, 6, and 15 days later. Macrophage phagocytosis was significantly depressed 6 and 15 days after exposure. Although macrophage colony formation was also initially depressed at day 2, markedly enhanced colony formation was observed at day 15. No significant effects were observed on granulocyte-monocyte progenitors from either spleen or bone marrow.

12663 (UR—3490-1776) **Renal effects of inhaled carbon tetrachloride and the influence of inhaled isopropanol: a comparison with the hepatic effects.** Henry, E.C. (Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics). 1979. Contract EY-76-C-02-3490. 108p. Dep. NTIS, PC A06/MF A01.

Thesis.

These experiments suggest that direct interaction of CCl_4 in the kidney leading to a toxic response via the peroxidative mechanism proposed for its hepatotoxicity probably does not occur in rats and mice. Although the kidney does contain lipid peroxidizable in vitro, renal metabolism of CCl_4 initiating membrane lipid peroxidation as monitored by loss G-6-Pase activity cannot be detected in vivo following exposures which cause severe peroxidation in liver. Like liver, kidney tissue contains P-450 activity which is inducible

and other data in the literature indicate its possible importance in mediating renal toxicity of some agents. However, the results of our experiments are more consistent with the hypothesis that renal effects of CCl_4 are secondary to the more severe response in liver.

MAN

REFER ALSO TO CITATION(S) 11973, 11974, 11975, 12467

12664 (BNL—51043) **Health effects of coal in the National Energy Plan.** Morris, S.C.; Novak, K.M.; Hamilton, L.D. (Brookhaven National Lab., Upton, NY (USA)). Apr 1979. Contract EY-76-C-02-0016. 30p. Dep. NTIS, PC A03/MF A01.

Estimates were made of the health damage from coal production and use (industrial and utility) expected under the President's National Energy Plan (NEP) for 1985 and 1990. These were compared with estimates of health damage in 1975 from coal combustion and from associated activities such as transportation. With population growth taken into account, the increase in disease and accidents in underground mining is about 70% between 1975 and 1985 and an additional 20% to 1990; this reflects an increase in the fraction of the total population exposed to this high risk activity. Health damage attributable to air pollution from coal combustion at utility and industrial plants is potentially large compared with health damage elsewhere in the fuel cycle. In comparing such estimates, note that, for air pollution, the uncertainty is much greater and the population at risk is generally much larger than for occupational risks, so that the individual risk is much lower. Despite increased coal use, sulfate exposure levels in 1985 are projected to decrease because of air pollution controls on both new and old plants. By 1990, SO_2 emissions from utility and industrial coal combustion will have climbed back above 1975 levels, and sulfate exposure levels also will have increased but not yet reached 1975 levels. This difference seems to be attributable to changes in population distribution. The bulk of the sulfate exposure in 1985 and 1990 clearly will come from pre-1975 plants.

12665 (BNL—51066, pp 48-50) **Criteria for occupational health monitoring in the fossil fuel conversion industries.** White, O. Jr. Oct 1979.

In Safety and Environmental Protection Division. Progress report, January 1, 1976-December 31, 1978.

Industrial Hygiene projects for the year include: Criteria for Occupational Health Monitoring in the Fossil Fuel Conversion Industries; and Working Group on Assessing Industrial Hygiene Monitoring Needs for the Coal Conversion and Oil Shale Industries.

12666 (DOE/EY/22874—59) **Misspectification of trend in spatial random-function interpolation with application to oxidant mapping. Technical report No. 28.** Faith, R.; Sheshinski, R. (Stanford Univ., CA (USA). Dept. of Statistics). Sep 1979. Contract EY-76-S-02-2874. 49p. Dep. NTIS, PC A03/MF A01.

In epidemiological studies of the effects of air pollution it is desirable to obtain estimates of the exposure to various pollutants of persons living throughout a geographical region under study. On the other hand, it is typically the case that pollution levels are measured at only a few locations. The problems of interpolating these values and of determining the accuracy of interpolation are amenable to analysis by way of spatial stochastic models. Such models can lead to an optimal interpolation technique, in a manner which is reviewed here. In Section 1 estimators based on a correctly and incorrectly specified constant mean are compared with estimators based on an unspecified constant mean. The comparison is done by calculating the corresponding values for the MSE. The ratios of the mean squared errors decreases with decreasing correlation between observations, and are, in general, very close to one. In section 2 estimation done with a specified linear trend function is compared to an estimation with an unspecified linear trend function. For interpolation, in general, the MSE's tend to be close except for high underlying correlation models. For extrapolation - the MSE values can be very different. The third section deals wiyh a biased partially constrained estimator versus a fully constrained universally unbiased estimator in the presence of a linear trend. In general, the biased and unbiased estimators have similar performance, except for very steep linear slopes of the trend. In Section 4 the Driging method was used for interpolating (mapping) values of oxidant levels from 1973 at 16 stations located in the San Francisco Bay Area. For this purpose constant and linear trends were used. The method requires for its application knowledge of the spatial covariance structure of the pollutant to which it is applied. Some difficulties encountered in estimating this for oxidant levels in the San Francisco Bay Area are mentioned.

12667 (EPRI-WS—78-110) **Proceedings: advisory workshop on carcinogenic effects of coal conversion.** Pack, D.H. (ed.). (Sigma Research, Inc., Richland, WA (USA)). Sep 1979. 120p. (CONF-7809189—). Dep. NTIS, PC A06/MF A01.

From Advisory workshop on carcinogenic effects of coal conversion; Pacific Grove, CA, USA (26 Sep 1978).

The technical papers, research recommendations, and conclusions of a workshop on carcinogenic effects of coal conversion are presented. Attention at this workshop was restricted to effects in the work place itself rather than effects on the general populace. Thus, the workshop dealt with plant-related matters such as sampling methods and sample handling, coal conversion processes, and experience with pilot plant operation. Methods of evaluating chemicals for carcinogenicity, including in vitro and in vivo testing and epidemiology, are covered in the discussion, technical papers, and recommendations. Some 59 research suggestions made at the workshop were distilled by the attendees to 18 specific research and development program recommendations in areas of industrial hygiene, medical surveillance, and epidemiology.

12668 (LA—8164-MS) **Permeation of protective garment material by liquid benzene.** Weeks, R.W. Jr.; McLeod, M.J. (Los Alamos Scientific Lab., NM (USA)). Dec 1979. Contract W-7405-ENG-36. 28p. Dep. NTIS, PC A03/MF A01.

The chemical compound benzene (C_6H_6) has a melting point of 5.5°C, a boiling point of 80.1°C, and is widely used as a solvent and chemical intermediate throughout the chemical, petrochemical, and associated industries. Although the toxic and carcinogenic natures of benzene have been known for some time, the strict 1 ppM regulation governing human exposure to it as a vapor or a liquid is relatively recent. Because of regulations and concern, the National Institute for Occupational Safety and Health requested that a study be performed to determine the rate at which liquid benzene would permeate certain protective garment materials. Accordingly, this work presents the results of such measurements on butyl, natural, neoprene, nitrile, surgical, Tyvek, vinyl and Viton rubbers and elastomers, and the following composites or supported elastomers: butyl-coated nylon, ethylene vinyl acetate/polyethylene-coated polyester, polyethylene-coated Tyvek, and polyvinyl alcohol. Included in these determinations were studies to correlate the protective clothing swelling or weight change following immersion in benzene with the actual rate at which the materials were permeated by benzene so that ultimately a screening test might be recommended concerning the permeation or lack of permeation through given materials.

12669 (LBL—9636) **Building a United States data base: Populations-at-Risk to Environmental Pollution.** Sacks, S.T.; Selvin, S.; Merrill, D.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1979. Contract W-7405-ENG-48. 20p. (CONF-7906145—1). Dep. NTIS, PC A02/MF A01.

From Conference on demographic and health information for aging research: resources and needs; Bethesda, MD, USA (25 Jun 1979).

A series of collaborative studies on the effects of environmental pollution on health were undertaken. A major study, Populations-at-Risk to Air Pollution (PARAP), was initiated in 1976. In October 1978, this project was extended to consider other environmental hazards and was renamed Populations-at-Risk to Environmental Pollution (PAREP). The PAREP project is divided into three main tasks: (1) creation of an integrated data base containing socioeconomic and demographic characteristics, air pollution levels for several important pollutants, and disease specific mortality statistics for the US on a county basis; (2) determination of populations at risk to various pollutants; and (3) analysis of possible associations between disease specific mortality and pollutant levels, taking into account socioeconomic and demographic variables.

12670 (PB—290578) **Interagency program in energy-related health and environmental effects research. Project status report.** (Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab.). Jan 1979. 170p. NTIS, PC A08/MF A01.

Projects reported in this document are grouped under one of four major research areas. The first area is identification of hazardous agents associated with non-nuclear energy technologies. These projects involved the development of qualitative methods for the identification of hazardous materials. The second area is development of more rapid and sensitive methods to evaluate dose to man. These projects focused on the development of quantitative methods for measuring degree of toxicity of various pollutants. The third area is determination of the metabolism and fate of hazardous agents associated with energy technologies. These projects involved determination of the physiological activities of several known carcinogens. The fourth research area is evaluation of hazards to man. In addition to studies of the effects of certain pollutants on humans, several of the projects concerned preparation of standard pollutant samples for use in future studies to increase the comparability of results. A list of additional studies funded under this program is included.

12671 (PB—290618) **An analysis of air pollution and its health effects: Washington, DC metropolitan area. Final report, 1973-1974.**

Seskin, E.P. (Resources for the Future, Inc., Washington, DC (USA)). Feb 1979. Contract EPA-68-03-2415. 78p. NTIS, PC A05/MF A01.

The study represents an extension of research begun under a contract (No. 68-01-3144) funded jointly by the U.S. Environmental Protection Agency and the U.S. Department of Transportation entitled, 'Air Pollution and Health in Washington, D.C.: An Analysis of Some Acute Health Effects of Air Pollution in the Washington Metropolitan Area.' In the original study three basic categories of data were analyzed: health information, air quality measurements, and weather factors. Since undertaking that analysis, additional air pollution and weather data became available. This study has attempted to examine the implications on previous conclusions of analyzing this expanded data base. The study period was again 1973-74 and focused on the Washington, DC Metropolitan Area. Statistical models were formulated to test the hypothesis that air pollution can aggravate the health status of a population and can result in increased utilization of certain types of medical care services. The statistical results indicated that air pollution levels had a very limited effect on the health-care utilization of the group practice even after the additional air pollution and meteorological data were examined.

12672 (PB—293729) **Carboxyhemoglobin trend in St. Louis blood donors, 1971-1975.** Stewart, R.D.; Newton, P.E.; Wu, A.; Kalbfleisch, J.H.; Stewart, T.A. (Milwaukee County Medical Complex, WI (USA); Medical Coll. of Wisconsin, Milwaukee (USA). Div. of Environmental and Occupational Medicine). Oct 1978. 25p. NTIS, PC A02/MF A01.

The Medical College of Wisconsin conducted a replicate survey in St. Louis--to determine whether reductions in the ambient CO concentration, as recorded at local air monitoring stations, would be reflected in lower COHb saturation in the population. The techniques used were identical to those used in a 1971 survey. Although the estimated CO emission from automobiles had decreased 10%, the median COHb level of non-smokers had not decreased. The lack of correlation between ambient CO levels recorded at air monitoring stations, estimated CO emissions, vehicle density, and COHb suggest that exogenous sources of CO other than vehicle exhaust are the dominant factors in producing COHb levels in excess of 1.5%.

12673 (PB—296903) **The health and environmental impacts of lead and an assessment of a need for limitations. Final report.** Ewing, R.A.; Bell, M.A.; Lutz, G.A. (Battelle Columbus Labs., OH (USA)). Apr 1979. Contract EPA-68-01-4318. 516p. NTIS, PC A22/MF A01.

This report reviews the available literature on lead and its compounds concerning physical and chemical properties, industrial technology and alternatives, environmental sources and emissions, environmental distribution, ecological effects, human health effects, and exposures to lead from various media determines the need for additional limitations on lead. More than 30 existing regulations directly or indirectly limiting exposure to lead have been identified. In reviewing the need for further limitations, the report addresses two specific questions: (1) What are the present levels of exposure in various population groups, and (2) Do these exposure levels represent a significant health hazard. An attempt is made to identify the relative contributions to total human exposure attributable to air, drinking water, and dietary intake. Using 11 assessment factors, the report prioritizes 12 exposure source classifications which might merit consideration for possible limitations. The impacts on health, the environment, and the economy of these potential limitations remain to be evaluated.

12674 (UCRL—15093) **State-of-the-art review of the behavioral toxicology of hydrogen sulfide.** Vigil, P.J. (Reference Dynamics, Santa Rosa, CA (USA)). Aug 1979. Contract W-7405-ENG-48. 58p. Dep. NTIS, PC A04/MF A01.

This report provides a state-of-the-art review of the behavioral toxicology of hydrogen sulfide. The effects on humans from chronic, low-level exposures are the primary concern, although acute, subacute, animal and in vitro studies are included to provide an overview of the biological activity of hydrogen sulfide. Recommended research is also addressed to resolve issues which are not conclusive in the literature.

12675 (Y-DK—109) **MOCA permeation of protective clothing.** Morrow, R.W.; Hamilton, J.H. (Oak Ridge Y-12 Plant, TN (USA)). 7 Nov 1979. Contract W-7405-ENG-26. 6p. Dep. NTIS, PC A02/MF A01.

At the Oak Ridge Y-12 Plant several types of protective clothing were tested for permeation by MOCA (4,-4' methylene bis-2-chloroaniline) and by MOCA-Adiprene L-100 mixtures. A sampling device was designed to allow the MOCA or the mixture to be placed on one side of the test specimen and the other side to be smear tested at later points in time. Results are presented in tables.

12676 **Cadmium: in vivo measurement in smokers and nonsmokers.** Ellis, K.J. (Brookhaven National Lab., Upton, NY); Vartsky, D.; Zanzi, I.; Cohn, S.H.; Yasumura, S. Contract EY-76-C-02-0016. *Science;* **205**: 323-325(20 Jul 1979).

Absolute amounts of cadmium (in milligrams) in the left kidney and concentrations of cadmium (micrograms per gram) in the liver were measured in vivo in 20 healthy adult male volunteers. Organ cadmium levels of smokers were significantly elevated above those of nonsmokers. No relationship was evident between body stores of cadmium (liver and kidney) and cadmium or β_2-microglobulin in urine or blood. The average total body burden of cadmium in man at age 50 is estimated to be 19.3 milligrams for nonsmokers and 35.5 milligrams for smokers (38.7 pack-year smoking history). Biological half-time for the whole body was, on average, 15.7 years (10- to 33-year range). Dietary absorption was 2.7 micrograms per day. Cigarette smoking resulted in the absorption of 1.9 micrograms per pack.

12677 **Estimating maximum limits for mutagenic potency from cytotoxic potency.** Carver, J.H.; Hatch, F.T.; Branscomb, E.W. (Univ. of California, Livermore). Contract W-7405-ENG-48. *Nature (London);* **279**: 154-156(May 1979).

It is shown that the cytotoxic potency of 22 chemical mutagens is highly correlated with their mutagenic potency as assayed in five rodent and human in vitro cell systems. It is suggested this relationship implies that the maximum potential mutagenic potency of such compounds may be reliably estimated from rapid and straight forward measurements of their cytotoxic potency.

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

REFER ALSO TO CITATION(S) 12670

12678 (AD-A—065326) **Hematologic effects in mice exposed to pulsed and cw microwaves. Annual report.** Ragan, H.A.; Phillips, R.D. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Feb 1979. Contract N00014-76-C-1154. 27p. NTIS PC A03/MF A01.

Mice were exposed in the far field of an anechoic chamber to 2880-MHz pulsed microwaves (2.3-microsec pulses, 100/sec) 3-7.5 hr daily for 60-360 hr. In two of five studies with 5-mW/sq cm pulsed microwaves there was a significant increase in bone marrow cellularity compared to the sham-exposed groups, but in the other three exposures at 5-mW/sq cm no significant effect was observed. Significant differences were occasionally seen in erythrocyte, leukocyte and platelet measurements from microwave-exposed groups, but were not consistently observed. The only effect seen in mice exposed to 5-mW/sq cm CW microwaves was a reduction in reticulocyte concentrations (P less than 0.02). In one of four exposures at 10-mW/sq cm pulsed microwaves, mean bone marrow cellularity was reduced (P less than 0.02) in the microwave-exposed mice, and in another group the concentration of circulating lymphocytes was increased (P less than 0.05). In only one exposure (10-mW/sq cm for 360 hr) was any effect noted on serum proteins: a reduction (P less than 0.02) to 5.1 + or - 0.29 g/dl in the exposed vs 5.6 + or - 0.36 g/dl in the sham-exposed mice. This was due to a decrease in alpha and beta-globulins, with no effect on albumin or gamma-globulin concentrations. No effect on bone marrow hematopoietic colony-forming units (CFU) was revealed by CFU-agar assay techniques following exposure of mice to 5-mW/sq cm pulsed microwaves. In 1 of 4 exposures of mice to 10-mW/sq cm pulsed microwaves there was a significant (P less than 0.05) increase in CFU-agar colonies.

12679 (AD-A—065671) **Cytochemical study related to laser application. Final report, 1 July 1974-30 September 1977.** Tsou, K.C. (Pennsylvania Univ., Philadelphia (USA). School of Medicine). Dec 1978. Contract DAMD17-74-C-4143. 27p. NTIS, PC A03/MF A01.

The use of laser has been on the increase in recent years. Protection against hazards created by the use of this new versatile tool in modern science has hence become necessary. The current consensus standard is that of ANSI Z136.1-1973. The Army has also set its own standard, and the Bureau of Radiological Health has also studied the criteria related to laser safety. While guidelines and control procedures have been stipulated by these agencies, fundamental biological effects data are required for evaluating exposure criteria for laser radiations. In the area of research related to the safety of the eye, cornea deserves investigation, since retention of a smooth, transparent cornea is of major importance in maintaining normal vision. The integrity of this surface could very well be challenged particularly for infrared lasers (lambda greater than 1.4 microns) where the laser energy is absorbed by the cornea or outer ocular media. Clinically, such damage could be checked through visual inspection with a slit lamp. If a permanent visual opacity is produced at the time of the radiation insult or develops as a chronic effect, a corneal transplant may be required. (Author)

12680 (AD-A—065989) **Biological effects of nonionizing electromagnetic radiation. volume 3, number 3. Quarterly report dec 78-mar**

79. Kleinstein, B.H.; Freedman, G. (Franklin Research Center, Philadelphia, PA (USA). Science Information Services Organization). Mar 1979. Contract HO-A01-78-1157. 56p. NTIS, PC A04/MF A01.

This quarterly digest presents current awareness information on the biological effects of nonionizing electromagnetic radiation (microwave and radio frequency) in the range of 0 Hz to 100 GHz. The effects of magnetic and electric fields (static and alternating) are also covered. Each issue contains abstracts of English and foreign current literature, summaries of ongoing research investigations, news items, and a directory of meetings and conferences.

12681 (AD-A—069842) **Measurements in the laser irradiated eye. Final report 1 Apr 1977-31 Mar 1978.** Welch, A.J.; Forster, L.D. (Texas Univ., Austin (USA). Bio-Medical Engineering Research Lab.). 15 Nov 1978. 78p. NTIS, PC A05/MF A01.

The work involves the fabrication and use of a small fiber optic probe to measure (1) the transmission of the ocular media which is the ratio of the total light intensity reaching the retina to the total light intensity incident on the cornea, and (2) the cross-sectional intensity profile of a minimally small image. Information concerning the resolution of the eye is derived from the small image measurements. The transmission of the ocular media, measured on a limited number of animals, compares well with some of the best previously reported data. The transmission was measured via a 600 micron diameter fiber optic probe which collected all the light from a 200 micron diameter irrading laser beam. Three lasers, providing seven wavelengths, were employed. The minimal images measured in the monkey eye were larger than values reported from subjective acuity tests or by diffraction theory. Some of this poor quality could be attributed to experimental error, but perhaps the most significant factor affecting eye quality was the fact that the neural controls for blinking, tearing, and micro-accommodation, which aid the eye in forming a retinal image, were inactive in the anesthetized animal.

12682 (BNL—51066, pp 34-38) **Tests on mutagenic effects of strong magnetic fields.** Baum, J.W.; Schairer, L.A.; Lindahl, K.L. Oct 1979.

In Safety and Environmental Protection Division. Progress report, January 1, 1976-December 31, 1978.

Mutagenic Studies reported here includes: Tests on Mutagenic Effects of Strong Magnetic Fields; Sensitivity of Drosophila melanogaster to Low Concentrations of the Gaseous 1,2-dibromoethane - I. Acute Exposures and II. Chronic Exposures.

12683 (CONF-781108—, pp 255-273) **Multivariate statistical methods applied to postnatal measures of neuromuscular and behavioral development in the rat exposed prenatally and neonatally to low-level electric fields.** Buschbom, R.L.; Doctor, P.G. (Battelle Pacific Northwest Lab., Richland, WA). Jul 1979.

From 4. DOE statistical symposium; Albuquerque, NM, USA (1 Nov 1978).

Studies have been undertaken to answer the question of whether electric fields produced by power transmission systems have detectible effects on living animals. Results of these studies will be used to establish reliable criteria for safe electric field exposure standards. One of the studies measures the effects on rats exposed prenatally and neonatally to a low-level electric field. A method for detecting subtle effects is to put these exposed animals through a series of tests to measure neuromuscular and behavioral development. The statistical analysis of this type of data presents some interesting problems. First is the question of what to measure. There have been attempts to develop indices to simplify analysis; however, they have generally met with severe criticism. The second problem is to estimate a dose-response relationship from data gathered from multiple tests. Traditional analysis of variance techniques are not applicable. Possible statistical approaches to these problems will be discussed. Cluster analysis appears relevant to the first problem because this technique may identify which of those tests could possibly measure the same underlying mechanism. A multivariate categorical data analysis approach to the dose-response relationship problem has two advantages. First, it simultaneously relates data from all the variables to dose level. Second, it recognizes the discrete nature of the variables.

12684 (SAND—77-7028) **Study of the possible effects of 110 kHz electromagnetic fields on humans.** (IIT Research Inst., Chicago, IL (USA). Physics Div.). Sep 1979. Contract EY-76-C-04-0789. 71p. Dep. NTIS, PC A04/MF A01.

Sandia Laboratories is developing an electronic, remotely detected credential for personnel identification within security areas. This credential will obtain power to drive its electronic circuitry by magnetid induction from a 110 kHz field. Since individuals wearing the credential must pass through the magnetic field, they will be exposed to the same magnetic field as the credential. The purpose of this report is to present data on the effects of the magnetic field on humans, in particular those wearing pacemakers.

12685 Correlation among the rates of dimer excision, DNA repair replication, and recovery of human cells from potentially lethal damage induced by ultraviolet radiation. Konze-Thomas, B.; Levinson, J.W.; Maher, V.M.; McCormick, J.J. (Michigan State Univ., East Lansing). *Biophys. J.;* **28**: No. 2, 315-325(Nov 1979).

The kinctics of excision repair in confluent cultures of diploid human fibroblasts after ultraviolet irradiation at varying doses was measured by three different methods: (1) removal of thymine-containing dimers, (2) DNA excision repair synthesis, and (3) biological recovery of cells from the potentially lethal effects of the irradiation. Each method gave similar results and indicated that the excision rate was dependent upon the number of thymine-containing dimers induced (substrate concentration). For example, at a dose of 40 J/m^2 (0.2% dimerization), the repair rate was 1.6 J/m^2 per h as determined by a modified method to measure the number of thymine-containing dimers remaining in DNA and 1.65 J/m^2 as measured by excision repair synthesis. At a dose of 7.5 J/m^2, the repair rate was 0.5 J/m^2 per h as measured by biological recovery, and at a dose of 7 J/m^2, the repair rate was 0.46 J/m^2 per h as measured by excision repair synthesis.

12686 Ultraviolet-induced reversion of cycl alleles in radiation-sensitive strains of yeast. Lawrence, C.W.; Christensen, R.B. (Univ. of Rochester, NY). *J. Mol. Biol.;* **122**: 1-21(1978).

Radiation-sensitive strains of the yeast, Saccharomyces cerevisiae, that carry the rev1-1 mutation exhibit greatly reduced frequencies of reversion of a number of auxotrophic mutations, much lower frequencies of forward mutation to auxotrophy and substantially reduced frequencies of reversion of cyc1-9, an ochre allele of the structural gene for iso-1-cytochrome c, when exposed to ultraviolet light. In contrast, the u.v.-induced reversion of cyc1-131, whose message contains the valine codon GUG in place of the AUG initiation codon, is unaffected by the presence of the rev1-1 mutations. This observation was confirmed using the rev1-3 as well as the rev1-1 mutation and four other cyc1 alleles out of 15 examined that behave in the same way were identified. It is clear, therefore, that while the REV1 gene function is required for the production of many mutational alterations at this locus, it is not for the production of certain specific events. The reason for this appears to depend on the genetic nature of these events rather than the kind of premutational lesion. The REV1 gene function is not required for the production of most base-pair additions or deletions and although necessary for the formation of most base-pair substitutions it is also not required for the substitutions that lead to the reversion of cyc1-131 and the proline mis•ense mutant, cyc1-115. The REV1 gene function is necesssary to produce identical substitutions at other sites, however, and also to produce different substitutions at the cyc1-131 site, suggesting that the special character of cyc1-115 and cyc1-131 is the requirement for a specific base-pair alteration at a specific site. The evidence of this kind of allele-specific control of u.v.-induced reversion must be accounted for by any proposed model of the mutagenic process and must also be accommodated by any scheme to test environmental mutagens.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 12601, 12668, 12679

12687 (AFMA-EF—13557-79-3) **Guidance for implementing the Department of Energy's Safety Analysis and Review System in Fossil Energy Programs.** Hurley, T.F.; Meyer, A.F. Jr. (Meyer (A.F.) and Associates, Inc., McLean, VA (USA)). Dec 1979. Contract AC02-79ET13557. 57p. Dep. NTIS, PC A04/MF A01.

On March 20, 1979, the Department of Energy (DOE) promulgated Order 5481.1, Safety Analysis and Review System. That directive established uniform requirements for preparing and reviewing safety analyses for DOE operations. Its purposes were to identify hazards and means of eliminating or controlling them, to assess risks, and to document management's authorizations of the operations. The Assistant Secretary for Fossil Energy requested A.F. Meyer and Associates (AFMA), Inc. to begin a study which would result in recommended procedures for implementing the DOE-wide safety analysis and review system (SARS) in the Office of Fossil Energy Programs (FE). This technical report is the result of that study.

12688 (NUREG/CR—1207) **Microbial aerosols from cooling towers and cooling sprays: a pilot study.** Adams, A.P.; Lewis, B.A.G. (Argonne National Lab., IL (USA)). Nov 1979. Contract W-31-109-ENG-38. 102p. (ANL/ES—83). Dep. NTIS, PC A06/MF A01.

Cooling towers and cooling sprays were investigated as sources of potential human pathogenic bacteria. Five steam-electric power plant sites were involved in field studies that focused primarily on enteric bacteria. Conclusions were: (1) the potential human health hazard from cooling towers using treated sewage effluent (reclaimed water) may not be as great as from those using polluted

surface waters; (2) current chlorination practice for bacterial slime control at cooling towers is inadequate to disinfect against potential human pathogens; (3) the numbers of enteric bacteria surviving the cooling-tower environment and aerosolization were low compared to the numbers of the so-called opportunistic bacteria; thus, the potential human health hazard from cooling-tower aerosols appears to be greater from opportunistic bacteria than from enteric pathogens; (4) aerosols from cooling sprays will pose little hazard downwind if droplet sizes are similar to those found at the study site; (5) E. coli is probably not a good indicator of cooling-tower microbial hazard, for several reasons discussed in the report; and (6) the bacterium of Legionnaires' disease can find optimum temperature and pH conditions for survival in most cooling-tower environments, although it is unlikely that there is adequate substrate for rapid growth of the organism in cooling towers.

12689 (UCRL—82656) **Health and research organization to meet complex needs of developing energy technologies.** Griffith, R.V. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1980. Contract W-7405-ENG-48. 7p. (CONF-800304—4). Dep. NTIS, PC A02/MF A01.

From 5. international congress of the International Radiation Protection Association; Jerusalem, Israel (8 Mar 1980).

At the Lawrence Livermore Laboratory, a unique safety technology organization has been established that is especially geared to respond to interdisciplinary health and safety questions in response to rapidly growing energy technology problems. This concept can be adopted by smaller organizations at a more modest cost, and still maintains the efficiency, flexibility, and technical rigor that are needed more and more in support of any industry health and safety problem. The separation of the technology development role from the operation safety organization allows the operational safety specialists to spend more time upgrading the occupational health and safety program but yet provides the opportunity for interchange with health and safety technology development specialists. In fact, a personnel assignment flow between an operational health and safety organization and a special technology development organization provides a mechanism for upgrading the overall safety capability and program provided by a given industrial or major laboratory.

GEOSCIENCES

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 11276, 11349, 11352, 11358, 11359, 11360, 12695

12690 (LA—8154-MS) **Gravity study of the Los Alamos Area, New Mexico.** Williams, L.M. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 21p. Dep. NTIS, PC A02/MF A01.

Profiles of gravity readings have been observed along two CXC seismic reflection lines recently recorded in Los Alamos County; one in Los Alamos Canyon, the other in Mortandad Canyon and on Sigma Mesa. These data have been merged with available gravity data in the Los Alamos area and a density profile across Los Alamos Canyon has been modeled to find the proper reduction density. The resulting Bouguer gravity map of the Pajarito Plateau suggests the basement deepens to the northeast. Two-dimensional computer modeling of the gravity profiles indicates that subsurface lenses of Tschicoma Formation along the west edge of the Pajarito Plateau may act as an effective basement, obscuring actual basement structures in that area. Thus, an alternative to the graben interpretation of the prominent gravity low in the area is that this low is due to density contrasts within the thick sequences of Quaternary volcanics present.

12691 (RHO-BWI-SA—26) **Basalt stratigraphy - Pasco Basin.** Waters, A.C.; Myers, C.W.; Brown, D.J.; Ledgerwood, R.K. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Oct 1979. Contract EY-77-C-06-1030. 11p. (CONF-791155—1). Dep. NTIS, PC A02/MF A01.

From Deccan volcanism and related basalt provinces in other parts of the world; Bombay, India (Nov 1979).

The geologic history of the Pasco Basin is sketched. Study of the stratigraphy of the area involved a number of techniques including major-element chemistry, paleomagnetic investigations, borehole logging, and other geophysical survey methods. Grande Ronde basalt accumulation in the Pasco Basin is described. An illustrative log response is shown. 1 figure. (RWR)

12692 **Calibration of the great American interchange.** Marshall, L.G. (Field Museum of Natural History, Chicago, IL); Butler, R.F.; Drake, R.E.; Curtis, G.H.; Tedford, R.H. *Science;* **204**: 272-279(20 Apr 1979).

From radioisotopic (potassium-argon) age determinations of tuffs and magnetostratigraphy of Late Tertiary mammal-bearing beds in Catamarca Province, northwest Argentina, refined estimates have been obtained for the durations and boundaries of beds of Chasicoan (Middle Miocene) through Chapadmalalan (Pliocene) age. An age of 9.0 million years is tentatively accepted for the Chasicoan-Huayquerian boundary, 5.0 million years for the Huayquerian-Montehermosan boundary, and 3.0 million years for the Montehermosan-Chapadmalalan boundary. Procyonids (raccoons and their allies), a group of North American origin, are first recorded in South America in a level immediately below a unit dated at 6.0 million years. Cricetine rodents of the tribe Sigmodontini are first recorded in South America in beds of Montehermosan age in Argentina. Ground sloths, a group of South American origin, first appear in North America in Early Hemphillian time in beds dated between 9.5 and 9.0 million years. The Panamanian land bridge was established by 3.0 million years ago, and an interchange of the terrestrial faunas was well under way by Late Blancan time (around 2.5 million years before present) in North America and by Chapadmalalan time in South America.

12693 **Cenozoic volcanic geology and probable age of inception of basin-range faulting in the southeasternmost Chocolate Mountains, California.** Crowe, B.M. (Los Alamos Scientific Lab., NM). *Geol. Soc. Am., Bull.;* **89**: 251-264(Feb 1978).

A complex sequence of Oligocene-age volcanic and volcaniclastic rocks form a major volcanic center in the Picacho area of the southeasternmost Chocolate Mountains, Imperial County, California. Basal-volcanic rocks consist of lava flows and flow breccia of trachybasalt, pyroxene rhyodacite, and pyroxene dacite (32 My old). These volcanic rocks locally overlie fanglomerate and rest unconformably on pre-Cenozoic basement rocks. South and southeast of a prominent arcuate fault zone in the central part of the area, the rhyolite ignimbrite (26 My old) forms a major ash-flow sheet. In the southwestern part of the Picacho area the rhyolite ignimbrite interfingers with and is overlain by dacite flows and laharic breccia. The rhyolite ignimbrite and the dacite of Picacho Peak are overlapped by lava flows and breccia of pyroxene andesite (25 My old) that locally rest on pre-Cenozoic basement rocks. The volcanic rocks of the Picacho area form a slightly bimodal volcanic suite consisting chiefly of silicic volcanic rocks with subordinate andesite. Late Miocene augite-olivine basalt is most similar in major-element abundances to transitional alkali-olivine basalt of the Basin and Range province. Normal separation faults in the Picacho area trend northwest and north parallel to major linear mountain ranges in the region. The areal distribution of the 26-My-old rhyolite ignimbrite and the local presence of megabreccia and fanglomerate flanking probable paleohighs suggest that the ignimbrite was erupted over irregular topography controlled by northwest- and north-trending probable basin-range faults. These relations date the inception of faulting in southeasternmost California at pre-26 and probably pre-32 My ago. A transition of basaltic volcanism in the area is dated at 13 My ago. 9 figures, 2 tables.

GEOPHYSICS

SEISMOLOGY AND TECTONICS

REFER ALSO TO CITATION(S) 12389

12694 (COO—3134-20) **Comprehensive study of the seismotectonics of the eastern Aleutian arc and associated volcanic systems. Annual progress report, March 1, 1979-February 29, 1980.** Jacob, K.H.; Davies, J.N.; Sykes, L.R. (Columbia Univ., Palisades, NY (USA). Lamont-Doherty Geological Observatory). 1979. Contract EY-76-S-02-3134. 111p. Dep. NTIS, PC A06/MF A01.

The modern and historic seismicity of the eastern Aleutian arc was thoroughly researched and shows clear evidence that the Shumagin Islands region of the arc has been ruptured at least partly by previous large or great earthquakes; has recurrence times for large earthquakes between 50 and 115 years; has presently the properties of a seismic gap, i.e., was not ruptured by a large or great earthquake for at least 76 years; shows a donut configuration of modest seismicity including high-stress-drop events around the rim of the expected rupture zone of a future large earthquake. From this combined evidence it is concluded that the likelihood for a large or great earthquake to occur within the Shumagin Island gap is high (about 50% probability) within the next decade and very high (about 80% to 90% probability) within the next three decades. This study includes detailed determinations of stress, stress-drop, and other source parameters of moderate earthquakes in the Shumagin islands gap, and similar results for the St. Elias earthquake near the Yakataga gap in the eastern Gulf of Alaska. Volcano seismicity, crustal

deformantion, and P-residuals continue to be monitored and analyzed in the eastern Aleutian arc segment. 36 figures, 3 tables.

VOLCANOLOGY

REFER ALSO TO CITATION(S) 11352

GEOPHYSICAL SURVEY METHODS

12695 (COO—4342-2) **Magnetotelluric interpretations in a crustal environment. Semi-annual report, 1 January 1978-30 June 1978.** Madden, T.R. (Massachusetts Inst. of Tech., Cambridge (USA)). Jun 1978. Contract EG-77-S-02-4342. 208p. Dep. NTIS, PC 10/MF A01.

Crustal variations in the conductivity and resistivity of the earth cause great complications in the surface distribution of electric currents and fields. At low frequencies the crust can be treated as a thin sheet, and the crustal conductivity variations can be incorporated into the thin sheet conductance variation. In the first model developed in this thesis, the layer below the thin sheet is a layer of finite conductivity. Thus the thin sheet model consists of a thin conducting sheet of variable conductivity over a general layered medium. In the earth the resistive layer below the surface conductive sheet is represented by the lower crust. The resistivity of the lower crust underneath the ocean is expected to be different from the resistivity of the lower crust below the continents. This difference in the lower crust resistivity value is taken into account in the Generalized Thin Sheet model. In this model the thin sheet is treated as an anisotropic thin sheet with different (parallel) conductivity and (perpendicular) resistivity variations. Specific examples in which conductivity and resistivity vary only in one direction were studied. It was found that in a crustal environment, approximation being made, it is possible to get simple analytical solutions for E variations perpendicular to the strike direction. Electric fields measured at a point are influenced not only by the conductivity and the resistivity of the medium at the point of measurement, but also by the electrical properties of the medium a considerable distance away. The method of imbedding was developed in which fields close to the point of measurement are computed at close spacings, while fields farther away are determined at larger spacings. These methods were applied to modelling magnetotelluric measurements on the island of Oahu. 107 figures, 13 tables.

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

REFER ALSO TO CITATION(S) 11275, 11358, 12693

12696 (AD-A—069405) **Physical and thermal disturbance and protection of permafrost. Special report.** Brown, J.; Grave, N.A. (Cold Regions Research and Engineering Lab., Hanover, NH (USA)). Mar 1979. 46p. NTIS, PC A03/MF A01.

This report is based on a review paper presented at the Third International Conference on Permafrost held in July 1978 at Edmonton, Canada. It reviews the literature covering 1974-1978 and covers subjects related to natural and human induced disturbance of terrain underlain by permafrost. Subjects included regard investigations undertaken in conjunction with oil and gas pipelines, terrain mapping, methods for estimating terrain sensitivity, methods of protecting terrain, and the thermal effects of off road transportation, oil spills, fire, removal of the surface soil layers, snow conditions, mining and other construction practices. Methods of protecting and restoring permafrost in the USSR are presented in tabular form. An appendix summarizes results of modeling and microclimatic investigation, and the distribution and properties of subsea, land-based, and alpine permafrost.

12697 (ORNL/TM—7052) **Thermal conductivity of the rocks in the Bureau of Mines Standard Rock Suite.** Morgan, M.T.; West, G.A. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 60p. Dep. NTIS, PC A04/MF A01.

Thermal conductivities of eight rocks from the Bureau of Mines Standard Rock Suite were measured in air over the temperature range 373 to 533°K (100 to 260°C). The thermal conductivities of these rocks were measured to furnish standards for future comparisons with host rock from prospective nuclear waste repository sites. The thermal conductivity at a given temperature decreased by as much as 9% after a specimen had been heated to the maximum temperature (533°K), but additional heating cycles had no further effect. This decrease was smallest in the igneous rocks and largest in the sedimentary types. Variations due to orientation were within the precision of measurements (+- 5%). In most cases the thermal conductivities were linear with the reciprocal of the temperature and were within 14% of published data obtained by other methods. Measurements were made by a cut-bar comparison method in which the sample was sandwiched between two reference or metering bars made of Pyroceram 9606 glass-ceramic. The apparatus consisted of a Dynatech Model TCFCM-N20 comparative thermal conductivity analyzer controlled by a Hewlett Packard Model 3052A data acquisition system. A program was written to increment and cycle the temperature in steps between predetermined initial and maximum values. At each step the thermal conductivity was measured after steady-state conditions were established. The rocks furnished by the Bureau of Mines were quarried in large and fairly homogeneous lots for use by researchers at various laboratories. To investigate any anisotropy, cores were taken from each rock cube perpendicular to each of the cube faces. Samples 2 in. in diameter and ~ 0.75 in. thick were prepared from the cores and were dried in a vacuum oven for at least one month prior to taking measurements.

GEOCHEMISTRY

REFER ALSO TO CITATION(S) 11203, 11275, 12693

OCEANOGRAPHY

12698 (CONF-790902—, pp 131-137) **Calculations of water waves and votex arrays by numerical solution of integro-differential equations.** Saffman, P.G.; Chen, B.; Szeto, R. (California Inst. of Tech., Pasadena). 1979.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

Steady gravity-capillary waves of permanent form on deep water and the shapes of vortices in a linear array are calculated numerically. For the waves, it is shown that finite-amplitude waves can bifurcate and new types of steady waves exist in which crests and troughs may be of unequal height. Gravity-capillary waves of maximum height are calculated. For the vorices, the shapes are found for various values of the size/separation. It is found that there exists a maximum size for given separation, and properties of the array are determined. The nonlinear equations were solved by Newton's method on the CDC STAR-100 computer at the CDC Service Center in Minneapolis. 11 figures.

12699 **Climate-related diachronous disappearance of Pulleniatina obliquiloculata in Late Quaternary sediments of the Atlantic and Caribbean.** Prell, W.L. (Brown Univ., Providence, RI); Damuth, J.E. *Mar. Micropaleontol.;* 3: 267-277(1978).

The planktonic foraminifera Pulleniatina obliquiloculata (Parker and Jones) undergoes several climatically controlled disappearances and reappearances in the equatorial Atlantic and Caribbean sediments during Late Quaternary time. One such disappearance occurs near the middle of the last glacial (Middle Wisconsin, middle Y zone, O^{18} stage 3). The age of this disappearance is time transgressive from approximately 60,000 y in the Gulf of Mexico, to 50,000 y in the western Caribbean, to 35,000 y in the equatorial Atlantic. The time-transgressive nature of P. obliquiloculata's disappearance from the Atlantic is thought to represent the decreasing width of P. obliquiloculata's adaptive zone as surface water salinities progressively increased during the glacial intervals due to expanding continental glaciers. A simple ecologic model predicts that P. obliquiloculata should disappear first from areas of high salinity and is consistent with observations that both modern sea-surface salinity and the age of the P. obliquiloculata biohorizon increase from the equatorial Atlantic to the Gulf of Mexico. The biohorizon, Y/sub P. obliq/, is a subdivision of Ericson's Y zone and occurs throughout the western equatorial Atlantic as well as throughout most of the Caribbean and Gulf of Mexico. Here, the horizon is useful for correlating and determining accumulation rates in continental margin sediments where rapid deposition often prevents piston cores from penetrating through the last glacial interval. Along the coast of Africa, in areas of coastal upwelling and the equatorward transport of cold water, the biohorizon does not occur.

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

COSMIC RADIATION

12700 **Radiation dose from solar flares at ground level.** O'Brien, K. (Department of Energy, New York (USA). Environmental Measurements Lab.). *Health Phys.;* 36: No. 1, 63-65(Jan 1979).

Wdowczyk and Wolfendale (Nature, 268, 510, 1977) concluded that a very large solar flare producing exposure of 10^4 rad at ground level (lethal to almost any organism) has a possible frequency of once per 10^5-10^6 yr. In the work reported similar results were obtained using a more elaborate model. Flares occuring from Febru-

ary 1956 to August 1972 were analyzed. The flare size distribution above the earth's atmosphere, and neutron flux, dose and dose equivalent at ground level at the latitude of Deep River, Canada, were calculated. The probable frequency of flares delivering various doses are given. Doses larger than 100 rad which have significant somatic effects on man and other animals may be delivered once in 10^6 years. The probability of 10^4 rad was found to be 10^{-5}/yr. These calculations apply only to high geomagnetic latitudes. Field reversals during which the geomagnetic field is much weaker than current values total about 10% of the past 4 million years. This suggests that a very large flare delivering a large dose worldwide at ground level cannot be ruled out.

STARS

12701 (ORO—5172-14, pp 59-62) **Nucleosynthesis calculations for the production of Li, Be and B.** Read S.M.; Glagola B.G.; Viola V.E. Aug 1979.

In Nuclear chemistry progress report.

Isotope ratios for Li, Be, and B nucleosynthesis were calculated for several different cosmic-ray source spectra. 2 tables. (RWR)

QUASI-STELLAR, RADIO, AND X-RAY SOURCES

REFER ALSO TO CITATION(S) 12778

12702 (LA-UR—80-80) **LASL gamma-ray burst astronomy program.** Klebesadel, R.W.; Evans W.D.; Laros, J.R. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 13p. (CONF-791164—1). Dep. NTIS, PC A02/MF A01.

From Conference on cosmic gamma ray bursts; Toulouse, France (25 Nov 1979).

Satellite observations of cosmic gamma bursts during the period from 1967 through 1979 by LASL are reviewed. The Vela, Pioneer Venus, and ISEE-3 instrument observations are discussed. (GHT)

SOLAR PHENOMENA

REFER ALSO TO CITATION(S) 11433

12703 (LA—8085-MS) **Solar photo rate coefficients.** Huebner, W.F.; Carpenter, C.W. (Los Alamos Scientific Lab., NM (USA)). Oct 1979. Contract W-7405-ENG-36. 97p. Dep. NTIS, PC A05/MF A01.

Photo rate coefficients based on wavelength dependent solar photon flux at 1 AU heliocentric distance have been determined for atomic hydrogen, carbon, nitrogen, and oxygen, and for some molecules formed from these elements. Branching ratios are considered for the various modes of decay of these molecules. Rates for some metastable states have been estimated. 107 references.

12704 (UCRL—80972(Rev.2)) **History of the sun's luminosity, 0 to 460,000 BP, based on the geologic record in light of recent climate theory.** Viecelli, J.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jan 1980. Contract W-7405-ENG-48. 17p. (CONF-791231—1). Dep. NTIS, PC A02/MF A01.

From 17. General Assembly of the International Union of Geodesy and Geophysics; Canberra, Australia (Dec 1979).

A solar luminosity index extending 460,000 years into the past is computed from ocean surface temperatures derived from the geologic record. It is estimated that the sun's luminosity fluctuated between 2% above to 5% below the current value over this period. The index shows pulses occurring at intervals of 75,000 to 120,000 years.

GALAXIES

12705 (CONF-790902—, pp 18-23) **Numerical experiments in the dynamics of galaxies on ILLIAC IV.** Miller, R.H. (Univ. of Chicago, IL); Smith, B.F. 1979.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

Fully three-dimensional n-body integrations that run on ILLIAC IV have been in routine use for the past three years in a variety of astronomical studies in the dynamics of galaxies. Some 10^5 particles move self-consistently under forces of Newtonian gravitation. The particles themselves are the source of the gravitational forces. The dynamical problem lends itself to a structure that fits the ILLIAC IV architecture very naturally; it should fit other array processors as easily. The complexity of results, coupled with their frequently unexpected nature, make graphic methods the only feasible way to study the results of a calculation. The program and the astronomical problems studied are briefly described. The motion pictures produced as the usual method of studying the computational results.

PLANETARY PHENOMENA

12706 (N—79-20553) **Multicomponent diffusion and energy characteristics of partially ionized plasma in the ionosphere of a planet.** Marov, M.A.; Kolesnichenko, A.V. (National Aeronautics and Space Administration, Washington, DC (USA)). Feb 1979. Translation of Preprint-123. 41p. NTIS, PC A03/MF A01.

The problem of energy and multicomponent ambipolar diffusion of plasma in the lower ionosphere of a planet with a weak magnetic field is considered.

ATMOSPHERIC PHYSICS

AURORAL AND IONOSPHERIC PHENOMENA

12707 (CONF-790902—, pp 10-17) **Simulation of gradient-drift striations on the ASC.** McDonald, B.E. (Navel Research Lab., Washington, DC); Ossakow, S.L.; Zalesak, S.T.; Zabusky, N.J. 1979.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

The evolution of many artificial ionospheric plasma clouds is governed by a simple two-dimensional model consisting of a continuity equation and a variable-coefficient elliptic equation. This type of model applies also to some nonplasma fluid flows. Despite the simplicity of the model, state-of-the-art methods are required to maintain integrity of the solution. These are explained in moderate detail. The one-level striation code used is highly vectorized and achieves in excess of 80% execution efficiency on the ASC. Typical results and timings for the code are given, and areas of current investigations are mentioned. 4 figures, 2 tables.

12708 (N—79-16481) **Comparison between the plasma line spectra in the F and aporadic E regions.** Cantor, I.J. (Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil)). Jun 1978. 16p. (In Portuguese). NTIS, PC A02/MF A01.

Comparisons of the spectral types observed in the F and E regions of the ionsphere when excited by intense HF radio waves are presented.

MAGNETOSPHERIC PHENOMENA

REFER ALSO TO CITATION(S) 12722

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

12709 **Fragment search in acyclic structures.** Randic, M. (Ames Lab., IA). *J. Chem. Inf. Comput. Sci.;* **18**: No. 2, 101-107(1978).

A graph theoretical algorithm is described which allows a search for fragments in acyclic structures. Although the topic discussed in the paper is of limited immediate use, it provides a basis for atom-by-atom matching which may be practical as a large number of unproductive matchings are eliminated from consideration. The approach is based on the concept of atom codes which register the number of neighbors one, two, and more bonds apart. Atom codes provide a means of storing information on a structure (i.e., connectivity) without an explicit use of atom labels. Atom codes also permit assignment of multiple labels to individual vertices based on some specified rules or prescribed properties.

BEAMS AND THEIR REACTIONS

12710 (LBL—9992) **Negative-hydrogen-ion production by backscattering from alkali-metal targets.** Schneider, P.J.; Berkner, K.H.; Graham, W.G.; Pyle, R.V.; Stearns, J.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 12p. (CONF-791057—2). Dep. NTIS, PC A02/MF A01.

From Workshop on hydrogen recycling; Livermore, CA, USA (17 Oct 1979).

Measurements have been made of the total backscattered D^- and H^- yields from Cs, Rb, K, Na and Li surfaces bombarded with D_2^+, D_3^+, H_2^+ and H_3^+ in the energy range 0.15 to 4 keV/nucleus. All measurements were made at a background pressure less than 10^{-9} Torr and the alkali-metal surfaces were evaporated onto a substrate in situ to minimize contamination of surfaces. For each target, the D^- and H^- yields exhibited maxima (as high as 8% per incident deuteron or proton for Cs); the maxima occurred at incident energies between 300 and 1000 eV/nucleus and always occurred at a lower incident energy for H than for D for a given target. Both the H^- and D^- yields decreased, at any measured energy, in going from Cs to Li in the order given above. Measurements of the H^- yield were also made for H_3^+ bombarding a W substrate, as a function of the work function of the target, as Li was deposited on the W. The work function of the target showed a minimum as the Li coverage was increased and the H^- yield showed a corresponding maximum

which was almost two orders of magnitude higher than the H^- yield for a thick Li target.

12711 (SAND—79-1774C) **Fundamental processes in ion plating.** Mattox, D.M. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 29p. (CONF-800205—2). Dep. NTIS, PC A03/MF A01.

From American Institute of Metallurgical Engineers meeting; Las Vegas, NV, USA (Feb 1980).

Ion plating is a generic term applied to film deposition processes in which the substrate surface and/or the depositing film is subjected to a flux of high energy particles sufficient to cause changes in the interfacial region of film properties compared to a nonbombarded deposition. Ion plating is being accepted as an alternative coating technique to sputter deposition, vacuum evaporation and electroplating. In order to intelligently choose between the various deposition techniques, the fundamental mechanisms, relating to ion plating, must be understood. This paper reviews the effects of low energy ion bombardment on surfaces, interface formation and film development as they apply to ion plating and the implementation and applications of the ion plating process.

ATOMIC AND MOLECULAR PROPERTIES

REFER ALSO TO CITATION(S) 12703

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

REFER ALSO TO CITATION(S) 12751

COLLISION PHENOMENA

REFER ALSO TO CITATION(S) 12213

12712 (AD-A—065825) **Atomic and molecular processes. Technical progress summary report no. 25, May-October 1978.** Biondi, M.A. (Pittsburgh Univ., PA (USA). Pittsburgh Atomic Sciences Inst.). 31 Oct 1978. Contract N00014-76-C-0098,. 12p. NTIS, PC A02/MF A01.

No abstract available.

12713 (COO—2640-11) **Reactions of ions with atomic and molecular free radicals. Progress report, May 1, 1979-April 30, 1980.** Gentry, W.R. (Minnesota Univ., Minneapolis (USA)). Jan 1980. Contract EY-76-S-02-2640. 9p. Dep. NTIS, PC A02/MF A01.

A very detailed study of the microscopic dynamics of the reaction $D_3^+ + F(^2p) \rightarrow FD^+ + D$, over the range of relative kinetic energy from 0.001 eV to 25 eV is reported. At very low collision energy, the total reaction cross section is governed by long-range forces - principally the charge-quadrupole interaction, which favors reactions on PI-type potential energy surfaces in the covalent interaction region. At high collision energies, a clear transition to reactions on a strongly repulsive potential energy surface is observed. The change in reaction dynamics is evident from the shape of the energy dependence of the total reaction cross section, and from a shift in the product angular distribution from 0° toward 180° in the center-of-mass coordinate system.

12714 (COO—2887-103) **Theoretical studies of highly ionized species. Progress report, March 1, 1979-February 28, 1980.** Dalgarno, A.; Victor, G.A. (Harvard Coll. Observatory, Cambridge, MA (USA)). Nov 1979. Contract EY-76-S-02-2887. 8p. Dep. NTIS, PC A02/MF A01.

Applications were continued of the relativistic random phase approximation and of the model potential method and the properties of highly stripped ionic systems were calculated. Charge transfer recombination and ionization were identified as important processes in plasmas and calculations were performed of rate coefficients for several systems at thermal energies. A theory was constructed of collision-induced fine-structure transitions involving protons and the interaction potentials for O^{3+} - H^+ were calculated. A study was made of some of the processes that occur when lithium and sodium are subject to laser radiation. Some progress was made towards the development of methods for calculating the effects on atomic systems of intense electric and magnetic fields.

12715 (COO—2944-T2) **Absorption of H and D Lyman-α radiation by O_2 molecules at high temperatures.** Chiang, C.C.; Skinner, G.B. (Wright State Univ., Dayton, OH (USA). Dept. of Chemistry). 1979. Contract EY-76-S-02-2944. 12p. Dep. NTIS, PC A02/MF A01.

Absorption cross sections of molecular oxygen were measured at the H and D Lyman-α wavelengths (1215.67 and 1215.34A) between 800 and 1700 K, the cross sections being given by the equation $\sigma(cm^2) = 4.2E\text{-}18 \exp(-3070/T)$. The absorption cross section for $v = 1$ is 9E-19 cm^2 and that for $v = 2$ is 7E-18 cm^2, compared to 1E-20 cm^2 for $v = 0$. Vibrational relaxation times were in agreement with literature data over the range of common temperatures.

12716 (LBL—9796) **Multiphoton processes in isolated atoms and molecules.** Sudbo, A.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 132p. Dep. NTIS, PC A07/MF A01.

Thesis.

The theory of coherent excitation of a multilevel quantum mechanical system is developed. Damping of the system is taken into account by the use of a density matrix formalism. General properties of the wave function and/or the density matrix are discussed. The physical implications for the behavior of the system are described, together with possible applications of the formalism, including the infrared multiphoton excitation of molecules, and optical pumping in alkali atoms. Experimental results are presented on the infrared multiphoton dissociation of molecules, followed by a discussion of the general features of this process. The experimental results were obtained using a crossed laser and molecular beam method, and the emphasis is on determining the properties of the dissociating molecule and the dissociation products. The dissociation process is shown to be described very well by the standard statistical theory (RRKM theory) of unimolecular reactions, a brief presentation of which is also included.

12717 (PNL-SA—7086) **Differential cross sections for electron emission in heavy ion-atom collisions.** Toburen, L.H. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1978. Contract EY-76-C-06-1830. 7p. (CONF-781113—41). Dep. NTIS, PC A02/MF A01.

From 5. conference on application of small accelerators; Denton, TX, USA (6 Nov 1978).

The systematics of differential ionization cross sections are explored for incident charged particles which possess atomic structure. Although little has been published regarding outer shell ionization by structured projectiles, sufficient data are becoming available to provide some insight into the collision process. This discussion concentrates on systematics of emission cross sections for the intermediate and high energy projectiles where the applicability of high energy approximations can be tested and the dramatic changes in emission spectra observed as the projectile energies decrease. Since heavy ion interactions are important in many research fields, it is particularly useful to determine where simple methods of cross section scaling may be appropriate.

ATOMIC AND MOLECULAR THEORY

REFER ALSO TO CITATION(S) 12712

12718 (COO—4264-6) **Oscillator strengths and transition probabilities for the intercombination transitions in Fe XXII.** Glass, R. (Pennsylvania State Univ., University Park (USA). Dept. of Computer Science). 1979. Contract EG-77-S-02-4264. 19p. Dep. NTIS, PC A02/MF A01.

Oscillator strengths and transition probabilities are evaluated for the intercombination transitions between the $2s^2\,2p$, $2s\,2p^2$ and $2p^3$ states of Fe XXII using configuration interaction wavefunctions. The fine-structure splittings have also been calculated. Some significant differences with previous calculations are obtained.

12719 **MCSCF optimization through combined use of natural orbitals and the Brillouin-Levy-Berthier theorem.** Ruedenberg, K.; Cheung, L.M.; Elbert, S.T. (Ames Lab., IA). *Int. J. Quant. Chem.*; **16**: No. 5, 1069-1101(Nov 1979).

A novel approach is developed for optimizing molecular orbitals within the context of a multiconfiguration self-consistent-field problem. The MCSCF wave function is determined through a sequence of eigenvalue problems in the multiconfiguration space and the single-excitation space. They are used iteratively to improve the natural orbitals, which in turn are related, by successively improved transformations, to the MCSCF orbitals. The mathematical problems arising out of this general concept are solved and the computational implementation is discussed. In many applications the method has proven itself as a powerful approach in forcing rapid convergence. Adaptation to spin and spatial symmetry is maintained throughout, and the procedure is applicable to excited states as well as to ground states. 3 figures, 2 tables.

GENERAL FLUID DYNAMICS

REFER ALSO TO CITATION(S) 12698, 12877, 12879

12720 (CONF-790902—, pp 138-143) **Steady high Reynolds number flow past a cylinder.** Fornberg, B. (California Inst. of Tech., Pasadena). 1979.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

Viscous flow past a circular cylinder becomes unstable around Reynolds number Re = 40. With a new numerical technique, based on Newton's method, steady (but unstable) solutions of high accuracy were obtained up to Re = 300. A new trend in the solution was found when the Reynolds number was increased above 260. The wake bubble begins to decrease in length as vorticity in the wake is convected back towards the body. The numerical calculations were performed on the CDC STAR-100 computer at the CDC Service Center in Minneapolis. 14 figures.

12721 (CONF-790902—, pp 159-166) **Numerical solution of the 3-D Navier-Stokes equations on the CRAY-1 computer.** Shang, J.S.; Buning, P.G.; Hankey, W.L.; Wirth, M.C.; Calahan, D.A.; Ames, W. 1979.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

A three-dimensional, time-dependent Navier-Stokes code using MacCormack's explicit scheme was vectorized for the CRAY-1 computer. Computations were performed for a turbulent, transonic, normal shock-wave-boundary layer interaction in a wind tunnel diffuser. The vectorized three-dimensional Navier-Stokes code on the CRAY-1 computer achieved a speed of 128 times that of the original scalar code processed by a CYBER 74 computer. The vectorized version of the code outperforms the scalar code on the CRAY computer by a factor of 8.13. A comparison between the experimental data and the numerical simulation is also made. 10 figures, 2 tables.

MAGNETOHYDRODYNAMICS

12722 (CONF-790902—, pp 149-158) **Evolution of the MHD sheet pinch.** Matthaeus, W.H.; Montgomery, D. (College of William and Mary, Williamsburg, VA). 1979.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

A magnetohydrodynamic (MHD) problem of recurrent interest for both astrophysical and laboratory plasmas is the evolution of the unstable sheet pinch, a current sheet across which a dc magnetic field reverses sign. The evolution of such a sheet pinch is followed with a spectral-method, incompressible, two-dimensional, MHD turbulence code. Spectral diagnostics are employed, as are contour plots of vector potential (magnetic field lines), electric current density, and velocity stream function (velocity streamlines). The nonlinear effect which seems most important is seen to be current filamentation: the concentration of the current density onto sets of small measure near a mgnetic X point. A great deal of turbulence is apparent in the current distribution, which, for high Reynolds numbers, requires large spatial grids ($\geq (64)^2$). 11 figures, 1 table.

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 12728

12723 (LBL—10035) **Dimuon production by high energy neutrinos and antineutrinos in the Fermilab fifteen-foot bubble chamber.** Orthel, J.L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1979. Contract W-7405-ENG-48. 134p. Dep. NTIS, PC A07/MF A01.

Thesis.

The Fermilab fifteen-foot bubble chamber/two-plane External Muon Identifier (EMI) hybrid detector filled with Ne(47% atomic)-H_2 is exposed to the quadrupole triplet beam ($<$ E/sub ν// sub $\mu/ > = 89$ GeV, $<$ E/sub anti ν//sub $\mu/ > = 60$ GeV). In 326,000 pictures there are 10,148 neutrino and 1773 antineutrino charged current events with two-plane EMI muon identification and muon momenta > 4 GeV/c. In this sample there are 55 $\mu^-\mu^+$X, 11 $\mu^-\mu^-$X and 0 $\mu^+\mu^+$X candidates with muon momenta > 4 GeV/c. The like-sign events are consistent with background. The opposite-sign dimuons occur at R/sub μ $\mu/ = 0.35 +- 0.10\%$ of the single muon rate. The ν/sub μ/-induced $\mu^-\mu^+$ rate is $0.20 +- 0.15\%$ below E/sub nu//sub $\mu/ = 100$ GeV and $0.50 +- 0.30\%$ above 100 GeV. In the opposite-sign dimuons there are 10 candidates with an associated V^0 implying $0.76 +- 0.36$ neutral strange particle per opposite-sign dimuon event. The production rate, excess of neutral strange particles, and kinematic distributions of the dimuon events are consistent with the charm model predictions. 56 references.

12724 (SLAC-PUB—2419) **Review of e^+e^- reactions in the energy range 3 to 9 GeV.** Kirkby, J. (Stanford Linear Accelerator Center, CA (USA)). Oct 1979. Contract EY-76-C-03-0515. 15p. (CONF-790885—11). Dep. NTIS, PC A02/MF A01.

From 9. international symposium on lepton and photon interactions at high energy; Batavia, IL, USA (23 Aug 1979).

The current experimental status of the tau and charmed particles in medium-energy e^+e^- annihilations is reviewed.

12725 (SLAC-PUB—2426) **Recent results in e^+e^- annihilation from SLAC.** Scharre, D.L. (Stanford Linear Accelerator Center, CA (USA)). Nov 1979. Contract EY-76-C-03-0515. 21p. (CONF-7909104—2). Dep. NTIS, PC A02/MF A01.

From 10. international symposium on multiparticle dynamics; Goa, India (25 Sep 1979).

Recent results from the Mark II and Crystal Ball experiments at SLAC are presented. Mark II results include measurement of direct photon production at the psi and observation of charmed baryon production. The Crystal Ball experiment sees evidence for a new state at 2.98 GeV produced in a radiative transition from the psi'.

12726 (SLAC-PUB—2442) **Theoretical interpretation of e^+e^- results.** Harari, H. (Weizmann Inst. of Science, Rehovoth (Israel); Stanford Linear Accelerator Center, CA (USA)). Dec 1979. Contract EY-76-C-03-0515. 17p. (WIS—79/62-Ph; CONF-790885—9). Dep. NTIS, PC A02/MF A01.

From 9. international symposium on lepton and photon interactions at high energy; Batavia, IL, USA (23 Aug 1979).

Portions of document are illegible.

Recent experimental results and theoretical ideas related to e^+e^- scattering are reviewed. 43 references.

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 12726

12727 (FERMILAB-CONF—79/15-THY) **Weak boson effects in charged current neutrino and antineutrino interactions at very high (DUMAND) energies.** Halprin, A.; Oakes, R.J. (Delaware Univ., Newark (USA). Dept. of Physics; Fermi National Accelerator Lab., Batavia, IL (USA); Northwestern Univ., Evanston, IL (USA). Dept. of Physics and Astronomy). Jan 1979. Contract EY-76-C-02-3000. 13p. Dep. NTIS, PC A02/MF A01.

The charged current neutrino and antineutrino total cross sections and y-distributions at very high energies (1 to 100 TeV) using the standard quark-parton model have been calculated. A range of W boson masses was considered which includes the value in the Weinberg-Salam model. The parametrization of the quark structure functions was chosen to fit the highest energy data available (100 to 200 GeV) so that scaling violations could be neglected. The W boson propagator causes the total cross sections to turn over and enhances the y-distributions at small y for high energies. It was shown that the presence of an admixture of antineutrinos in the flux as large as 25% does not mask the effect of the W boson propagator on the neutrino cross section or on the neutrino y-distribution. The expected flux spectrum of atmospheric neutrinos was folded in and counting rates per bin over a range of intervals in E/sub ν/ and y were computed for a 1 km^3 (10^9 ton) DUMAND array. It was also found that a 25% admixture of antineutrinos in the flux did not appreciably affect these counting rates.

STRONG BARYON-INDUCED INTERACTIONS

12728 (COO—2232A-81) **Search for direct photon production at large p/sub T/ in proton-proton collisions at $\sqrt{s} = 62.4$ GeV.** Tannenbaum, M.J. (Rockefeller Univ., New York (USA)). 1979. Contract EY-76-C-02-2232. 8p. (CONF-790885—5). Dep. NTIS, PC A02/MF A01.

From 9. international symposium on lepton and photon interactions at high energy; Batavia, IL, USA (23 Aug 1979).

Preliminary results from the CCOR Group, Experiment R-108, at the CERN ISR are reported. In addition, previously published results from the Rome-Brookhaven-CERN Group at the ISR will be reviewed.

12729 (ORO—1316-T1) **Nuclear structure at intermediate energies. Progress report, April 1, 1979-March 31, 1980.** Phillips, G.C.; Mutchler, G.S. (Rice Univ., Houston, TX (USA). Bonner Nuclear Labs.). 1979. Contract EY-76-C-05-1316. 43p. Dep. NTIS, PC A03/MF A01.

Progress was made during the year on data analysis on ten experimental topics. Theoretical contributions were made to four of these topics. Three publications resulted. During the year a new experiment ($p + p \rightarrow p\pi^+ n$) was initiated, and preliminary analysis shows large polarization asymmetries. Two Ph.D. degrees were awarded to student members of the group. Three papers in this report with significant data are indexed individually.

12730 (ORO—1316-T1, pp 14-15) **Production of the Δ^{++} in the reaction $pp \rightarrow p\pi^+ n$ at 800 MeV.** Hudomalj-Gabitzsch, J.; Mutchler, G.S. 1979.

In Nuclear structure at intermediate energies. Progress report, April 1, 1979-March 31, 1980.

The differential cross section is shown over the momentum range 400 to 1000 MeV/c. 1 figure. (RWR)

12731 (ORO—1316-T1, pp 16-22) **Δi production in the pp → ppπ° reaction at 800 MeV.** Pepin, G.P.; Mutchler, G.S.; Furic, M. 1979.

In Nuclear structure at intermediate energies. Progress report, April 1, 1979-March 31, 1980.

The differential cross section is plotted as a function of proton momentum for several pair of angles. Kinematically complete experiments were performed. Analysis was by boson-exchange model. 1 figure, 1 table. (RWR)

12732 (ORO—1316-T1, pp 16, 23-29) **Studies of the spin dependence of p + p → πX.** Mutchler, G.S.; Pinsky, L.S. 1979.

In Nuclear structure at intermediate energies. Progress report, April 1, 1979-March 31, 1980.

The beam-spin-asymmetry was measured for 14 pairs of angles in a kinematically complete experiment, and the results are shown. It was necessary to include the full π-N dynamics in the π-exchange diagram to reproduce the measured asymmetries. 4 figures, 1 table. (RWR)

STRONG MESON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 12726, 12751

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

REFER ALSO TO CITATION(S) 12726

12733 (FERMILAB-CONF—79/65-THY) **Topics in perturbative QCD beyond the leading order.** Buras, A.J. (Fermi National Accelerator Lab., Batavia, IL (USA)). Aug 1979. Contract EY-76-C-02-3000. 58p. Dep. NTIS, PC A04/MF A01.

The basic structure of QCD formulae for various inclusive and semi-inclusive processes is presented. Next to leading order QCD corrections to inclusive deep-inelastic scattering are discussed in some detail. The methods for calculations of QCD corrections (leading, next to leading) to semi-inclusive processes are outlined. Some results of these calculations are discussed. 58 references.

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 12726, 12735

12734 **Inelastic Compton scattering in two-dimensional QCD.** Fleishon, N. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Nucl. Phys., B;* **151**: No. 2, 261-292(7 May 1979).

The hadronic contribution to inelastic Compton scattering is computed to leading order in N^{-1} in two-dimensional QCD. Various kinematic limits are investigated. It is found that in the dual-Regge region of soft processes the photons interact as purely hadronic systems. Modification of dimensional counting rules is indicated by a study of a large-angle scattering analogue. In several hard inclusive non-light-cone processes, parton model ideas are confirmed. The impulse approximation is valid in a Bjorken-Paschos-like limit with very virtual photons. A Drell-Yan type annihilation mechanism is found in photoproduction of massive lepton pairs, leading to identification of a parton wave function for the photon.

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 12741

12735 (FERMILAB-Conf—79/87-THY) **Weak interactions and gauge theories.** Gaillard, M.K. (Fermi National Accelerator Lab., Batavia, IL (USA)). Dec 1979. Contract EY-76-C-02-3000. 16p. (CONF-790885—13). Dep. NTIS, PC A02/MF A01.

From 9. international symposium on lepton and photon interactions at high energy; Batavia, IL, USA (23 Aug 1979).

The status of the electroweak gauge theory, also known as quantum asthenodynamics (QAD), is examined. The major result is that the standard WS-GIM model describes the data well, although one should still look for signs of further complexity and better tests of its gauge theory aspect. A second important result is that the measured values of the three basic coupling constants of present-energy physics, g/sub s/, g, and $\sqrt{(5/3)}g'$ of SU(3)/sub c/ x SU(2)$_L$ x U(1), are compatible with the idea that these interactions are unified at high energies. Much of the paper deals with open questions, and it takes up the following topics: the status of QAD, the scalar meson spectrum, the fermion spectrum, CP violation, and decay dynamics. 118 references, 20 figures. (RWR)

12736 (UH—511-367-79) **Fun with W, Z, H, and G's.** Ma, E. (Hawaii Univ., Honolulu (USA). Dept. of Physics and Astronomy). Nov 1979. Contract EY-76-C-03-0511. 7p. Dep. NTIS, PC A02/MF A01.

Possible departures from the canonical orthodoxy represented by the Weinberg-Salam model and QCD are discussed. A model with 2 W's and 2 Z's is presented, as well as speculations on the Higgs-boson mass and the number of flavors and colors. 14 references.

STRONG INTERACTIONS, GENERAL

REFER ALSO TO CITATION(S) 12734

12737 (ORO—3992-372) **de Sitter fibers and SO(3,2) spectrum generating group for hadrons.** Bohm, A. (Texas Univ., Austin (USA). Dept. of Physics). Oct 1979. Contract EY-76-S-05-3992. 29p. (CONF-790246—1). Dep. NTIS, PC A03/MF A01.

From Symposium on symmetries in science; Carbondale, IL, USA (Feb 1979).

Ideas of general relativity theory are applied to hadron physics. A vague description of Drechsler's de Sitter fiber bundle is given first, followed by a brief review of Biedenharn and van Dam's dynamical stability group, which functions as a spectrum-generating group. The theory presented can be understood as a combination of the two above proposals: the system which this theory describes is called the rigid relativistic rotator. This idea is slightly generalized by allowing for a discrete number of radii of the de Sitter fibers instead of one radius, which can be interpreted as taking for the de Sitter radius an operator with discrete spectrum instead of a number, and by taking-instead of Biedenharn and van Dam's representations of SO(3,2)--a more complicated representation. This generalization is the general relativistic rotator. The particle spectrum of this de Sitter rotator is then compared with the experimental data on experimental evidence for the de Sitter spectrum. 2 figures, 1 table. (RWR)

12738 (SLAC-PUB—2433) **QCD phenomenology of the large P/sub T/ processes.** Stroynowski, R. (Stanford Linear Accelerator Center, CA (USA)). Nov 1979. Contract EY-76-C-03-0515. 77p. (CONF-790774—3). Dep. NTIS, PC A05/MF A01.

From SLAC summer institute on particle physics: quantum chromodynamics; Stanford, CA, USA (9 Jul 1979).

Quantum Chromodynamics (QCD) provides a framework for the possible high-accuracy calculations of the large-p/sub T/ processes. The description of the large-transverse-momentum phenomena is introduced in terms of the parton model, and the modifications expected from QCD are described by using as an example single-particle distributions. The present status of available data (π, K, p, p-bar, eta, particle ratios, beam ratios, direct photons, nuclear target dependence), the evidence for jets, and the future prospects are reviewed. 80 references, 33 figures, 3 tables. (RWR)

STRONG INTERACTIONS, BARYON NO.=0

REFER ALSO TO CITATION(S) 12726, 12778

12739 (COO—1545-268) **Ghost glueball and pseudoscalar mixing.** Palmer, W.F.; Pinsky, S.S. (Ohio State Univ., Columbus (USA). Dept. of Physics). 1979. Contract EY-76-C-02-1545. 5p. Dep. NTIS, PC A02/MF A01.

Comments are made on some work of Rosenzweig, Schecter, and Trahern, who construct an effective Lagrangian for QCD involving a pseudoscalar ghost glueball field. It is pointed out that a successful description of pseudoscalar mixing written down some years ago indeed requires a pseudoscalar ghost.

12740 **Little bag.** Brown, G.E.; Rho, M. (State Univ. of New York, Stony Brook (USA). Dept. of Physics). *Phys. Lett., B;* **82**: No. 2, 177-180(26 Mar 1979).

A quark bag model for nucleons and isobars is made with pions existing only outside the bag. The pion field is introduced so as to ensure continuity of the axial-vector current at the boundary of the bag. It is argued that the bag can be quite small, of radius approximately $(h/2\pi)$/msub(n)c where msub(n) is the nucleon mass. The energy of the small bag is much larger than msub(n) c^2, but self-energy processes, especially those involving the pion, are invoked in order to bring the nucleon energy down to its physical value. The resulting theory looks very much like the old Yukawa theory for a pion with a small distributed source, the source now being described in terms of quarks.

12741 **Bounds on particle masses in the Weinberg-Salam model.** Politzer, H.D.; Wolfram, S. (California Inst. of Tech., Pasadena (USA)). *Phys. Lett., B;* **82**: No. 2, 242-246(26 Mar 1979).

Various conditions necessary for the self-consistency of the Weinberg-Salam model are used to place constraints on fermion and Higgs Boson masses. It is found that spontaneous symmetry breakdown cannot generate fermion masses in excess of about 300 GeV.

12742 Heavy quark potential and the UPSILON, J/psi systems. Richardson, J.L. (Stanford Linear Accelerator Center, CA (USA)). *Phys. Lett., B;* **82**: No. 2, 272-274(26 Mar 1979).

A new heavy quark potential is proposed which incorporates the two concepts of asymptotic freedom and linear quark confinement in a unified manner. It is shown that this potential reproduces the spectroscopy of the triplet canti c system charmonium and the triplet banti b system upsilonium. The only parameters other than a scale size A, are the quark masses.

STRONG INTERACTIONS, BARYON NO.=1

REFER ALSO TO CITATION(S) 12740, 12741

12743 (ORO—3992-368) **Leptonic decays of the Ω^-.** Dicus, D.A.; Letaw, J.R. (Texas Univ., Austin (USA). Center for Particle Theory). Aug 1979. Contract EY-76-S-05-3992. 27p. Dep. NTIS, PC A03/MF A01.

Branching ratios, widths, and lepton energy spectra are derived for the leptonic decays of the Ω^- into Ξ^0 and Ξ^{0*}. The calculations are made by hypothesizing that higher order multipoles in an expansion of the baryon current are zero. The axial vector coupling is determined using the bag model.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

12744 Polarization of the deuteron in the reaction $p+p \rightarrow d+\pi^+$. Niskanen, J.A. (State Univ. of New York, Stony Brook (USA). Dept. of Physics). *Phys. Lett., B;* **82**: No. 2, 187-190(26 Mar 1979).

The polarization of the deuteron in the reaction $pp \rightarrow d\pi^+$ is calculated with an isobar model, and effects of varying the interactions are investigated. The prediction for the vector polarization is rather small, generally less than 10%, and sensitive to the interaction model used, whereas the tensor polarization is found to be large and very model independent.

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 12735

FIELD THEORY

REFER ALSO TO CITATION(S) 12734, 12735, 12736, 12738

12745 (ORO—3992-374) **Geometrical theory of ghost and Higgs fields and SU(2/1).** Ne'eman, Y.; Thierry-Mieg, J. (Texas Univ., Austin (USA). Center for Particle Theory; Tel Aviv Univ. (Israel). Dept. of Physics and Astronomy; California Inst. of Tech., Pasadena (USA); Observatoire de Paris, Section de Meudon, 92 (France)). Oct 1979. Contract EY-76-S-05-3992. 15p. (CONF-7903102—2). Dep. NTIS, PC A02/MF A01.

From 8. international colloquium on group theoretical methods in physics; Kiriat Anavim, Israel (25 Mar 1978).

That a Principal Fiber Bundle provides a precise geometrical representation of Yang-Mills gauge theories has been known since 1963 and used since 1975. This work presents an entirely new domain of applications. The Feynman-DeWitt-Fadeev-Popov ghost-fields required in the renormalization procedure are identified with geometrical objects in the Principal Bundle. This procedure directly yields the BRS equations guaranteeing unitarity and Slavnov-Taylor invariance of the quantum effective Lagrangian. Except for one ghost field and its variation, this entire symmetry thus corresponds to classical notions, in that it is geometrical, and completely independent of the gauge-fixing procedure, which determines the quantized Lagrangian. These results may be used to fix the signs associated with the various ghost loops of quantum supergravity. The result is based upon the identification of a geometrical Z(2) x Z(2) double-gradation of the generalized fields in supergravity: [physical/ghost] fields and [integer/half integer] spins. Then the case of a supergroup as an internal symmetry gauge is considered. Ghosts geometrically associated to odd generators may be identified with the Goldstone-Nambu Higgs-Kibble scalar fields of conventional models with spontaneous symmetry breakdown. As an example, the chiral SU(3)/sub L/ x SU(3)/sub R/ flavor symmetry is realized by gauging the supergroup Q(3).Lastly, the main results concerning asthenodynamics (Weak-EM Unification) as given by the ghost-gauge SU(2/1) supergroup are recalled. 1 table. (RWR)

SCATTERING THEORY

12746 Micro-analyticity of the S-matrix and related functions. Kashiwara, M.; Kawai, T. (Institute of Advances Study, Princeton, NJ (USA). School of Mathematics; Kyoto Univ. (Japan). Research Inst. for Mathematical Sciences); Stapp, H.P. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; European Organization for Nuclear Research, Geneva (Switzerland)). *Commun. Math. Phys.;* **66**: No. 2, 95-130(1979).

It is shown that the singularity spectrum of the phase space integral associated with any partially ordered Landau diagram is confined to a variety defined by a set of modified Landau equations. These equations are similar to the ordinary Landau equations but involve limiting procedures. The variety defined by the modified equations coincides with the variety defined by the ordinary equations except at points called u=O points. Next the causal parts of the sets defined by the modified Landau equations are defined, in a natural way, and it is conjectured that the singularity spectrum of the S-matrix is confined to the union of the causal parts of the singularity spectra of the phase space integrals. An analogous conjecture on general bubble diagram functions asserts that the singularity spectrum of each of these functions is confined to sets defined by the modified Landau equations augmented by appropriate positive-α and negative-α conditions. Generalized Landau equations are introduced. These equations do not involve limiting procedures, but provide a useful partial characterization of the srts defined by the modified Landau equations augmented by these positive-α and negative-α conditions.

PHYSICS RESEARCH (CONT.)

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 12744

12747 (ORO—5172-14, pp 50-53) **DWBA analysis of the $\alpha + \alpha$ reaction at 10 to 40 MeV/u.** Glagola, B.G.; Nadasen, A.; Chant, N.S.; Viola, V.E. Aug 1979.

In Nuclear chemistry progress report.

Measured center-of-mass angular distributions of the ^{4}He(α, ^{6}Li)D reaction at 80.8 to 158.2 MeV are compared with calculations using an exact finite-range nucleon-transfer code with several potentials. The calculations are in good agreement with the systematic trends. 1 figure. (RWR)

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

12748 (ORO—5172-14, pp 54-57) **Cross sections for A = 6 and 7 isotopes in the ^{4}He + ^{4}He reaction.** Glagola, B.G. (Univ. of Maryland, College Park); Mathews G.J.; Breuer, H.; Viola, V.E.; Roos, P.G.; Nadasen, A.; Austin, S.M. Aug 1979.

In Nuclear chemistry progress report.

The ratio of the total cross section for A = 7 products to that for A = 6 products is plotted for bombarding energies from 61.5 to 158.2 MeV. It is apparent that the $\alpha + \alpha$ reaction cannot have any significant role in synthesizing sufficient ^{7}Li to yield the solar-system abundance ratio ^{7}Li/^{6}Li = 12.5 for any mechanism invoking reactions induced by energetic particles (E > 50 MeV). Cosmological consequences of these results are discussed. 2 figures. (RWR)

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 12784

12749 (ORO—5172-14, pp 46-49) **Calculation of Z ≧ 3 mass, energy and angular distributions in the p + ^{12}C reaction.** Goekmen, A.; Glagola, B.G.; Mathews, G.J.; Viola, V.E. Aug 1979.

In Nuclear chemistry progress report.

Angular distributions and total cross sections were calculated in a cluster intranuclear cascade model for the production of A = 6,

7, 10, and 11 nuclides in the reaction p + ^{12}C at 100 MeV. 1 figure. (RWR)

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

MASS, ABUNDANCE, AND BINDING ENERGY

12750 Precise measurement of the charge-distribution differences of the oxygen isotopes. Miska, H.; Norum, B.; Hynes, M.V.; Bertozzi, W.; Kowalski, S.; Rad, F.N.; Sargent, C.P.; Sasanuma, T. (Massachusetts Inst. of Tech., Cambridge (USA). Lab. for Nuclear Science); Berman, B.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Phys. Lett., B;* **83**: No. 2, 165-168(7 May 1979).

The charge form factors of ^{17}O and ^{18}O have been measured by electron scattering, and the charge-distribution differences between these nuclei and ^{16}O have been extracted. The spherical part of the ^{17}O distribution is very close to that of ^{16}O while the ^{18}O distribution is substantially different.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 12754

12751 (INIS-mf—5273, pp 146-170) **Interaction of pions and kaons with nucleons and nuclei.** Dover, C.B. (Brookhaven National Lab., Upton, NY (USA)). 1978.

From Journees d'etudes saturne, II; Aussois, France (3 Oct 1977).

The Brookhaven Medium Energy Physics Program is outlined. A general discussion of hadronic reactions with nuclei establishes a perspective of the experimental quantities to be extracted from data and opens theoretical questions about the reaction mechanism. Emphasis is then put on kaons in the elementary interaction of π, K^{+-} with nucleons. The π and K reactions with nuclei are concerned with the following: elastic scattering (total cross section π, K); inelastic scattering and the selection rules (π,K,p,e,d); the kaonic atoms, (K^-,π^-); the next generation (K^-, K^+) (K^+, K^+p) and (K^+,π^+).

12752 Analyzing power in the mass-six supermultiplet system. Flynn, E.R.; Brown, R.E.; Haglund, R.F. Jr.; Hardekopf, R.A.; Schmelzbach, P.A.; Sunier, J.W. (Los Alamos Scientific Lab., NM (USA)); Oertzen, W. von (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.)). *Nucl. Phys., A;* **319**: No. 1-2, 61-70(30 Apr 1979).

Analyzing powers A/sub y/ for reactions leading to several members of the mass-six supermultiplet have been measured via the t(pol)+^{9}Be→^{6}Li + ^{6}He, ^{6}Li*+^{6}He reactions at 17 MeV triton energy. In contrast to the previously measured differential cross sections, which show symmetry about 90° for both the S=1 and S=0 channele, a/sub y/ is consistent with being antisymmetry about 90° for the S=0 channel and is approximately symmetric for the S=1 channel. An antisymmetric result for the S=0 isospin-multiplet channel could be understood by invoking isospin symmetry, in analogy to the well-known Barshay-Temmer theorem. The reaction leading to the S=1 channel is discussed in terms of a direct reaction mechanism; however, the symmetry of A/sub y/ about 90° is not understood.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

12753 α-width of the lowest T=2 state in ^{28}Si. Ikossi, P.G.; Snover, K.A.; Osborne, J.L.; Adelberger, E.G. (Washington Univ., Seattle (USA). Nuclear Physics Lab.); McDonald, A.B. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). *Nucl. Phys., A;* **319**: No. 1-2, 109-121(30 Apr 1979).

The E/sub x/=15.22 MeV, J/sup π/=0$^+$ T=2 level in ^{28}Si has been studied as an isospin forbidden resonance in ^{24}Mg(α,α_0)^{24}Mg and GAMMA/sub α,c.m./=222+-22 eV was obtained. This corresponds to a reduced width approximately 1.4x10^{-4} times the Wigner limit, which is the largest known reduced α_0 width of a 0$^+$ T=2 state in the A=4n T/sub z/=0 nuclei. The existence of a J/sup π/=0$^+$ state at E/sub x/=15.12 MeV with GAMMA/sub c.m./=11+-2 keV and GAMMA/sub α//GAMMA=0.7+-0.1 has also been established. Narrow resonances at E/sub x/=15.08, 15.29 and 15.31 MeV were also observed.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 12753

12754 (ORO—5172-14, pp 43-45) **Measurement of total heavy fragment mass, energy and angular distributions for the ^{4}He + ^{12}C and ^{4}He + ^{27}Al reactions.** Goekmen, A.; Glagola, B.G.; Breuer, H.; Viola V.E. Aug 1979.

In Nuclear chemistry progress report.

Mass spectra for the reactions at 80 MeV are shown. Yield patterns for the ^{27}Al case show a preference for the formation of A = 4n products. Examination of the energy spectra as a function of bombarding energy shows a transition from final products dominated by two-body processes to more complex processes characteristic of multibody final states. 2 figures. (RWR)

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

12755 Calculation of nuclear rms radii using a Skyrme interaction with a state dependent effective mass. Castel, B. (Oak Ridge National Lab., TN (USA)); Goeke, K. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). *Phys. Lett., B;* **82**: No. 2, 160-162(26 Mar 1979).

A modified Skyrme interaction constructed to yield a local enhancement of the effective mass at the Fermi surface is used to calculate properties of the valence orbits in the calcium region. The origin of the improvements on ordinary density dependent Hartree-Fock calculations is discussed in terms of core polarization diagrams and nonlocality of nuclear potentials.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 12765

12756 (CONF-790484—3) **Cross section measurement for the ^{52}Cr(n,p)^{52}V reaction near threshold.** Smith, D.L.; Meadows, J.W. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 21p. Dep. NTIS, PC A02/MF A01.

From American Physical Society meeting; Washington, DC, USA (23 Apr 1979).

Cross sections for this reaction were determined in the range 5.3 to 9 MeV using a previously-reported pulsed-accelerator technique to measure gamma ray activity from 3.75 m ^{52}V. Very few experimental data have been reported for this reaction, and little was known about the threshold region prior to the present experiment. The results of this work (in conjunction with other available cross section information) were used in the computation of fission-spectrum averages which are of interest for reactor applications.

12757 (ORO—5172-14, pp 21-23) **Structure in the energy spectra of damped products from the ^{56}Fe + ^{56}Fe reaction.** Mignerey, A.C. (Argonne National Lab., IL); Wolf, K.L.; Breuer, H.; Glagola, B.G.; Viola, V.E.; Wilcke, W.; Schroeder, U.; Huizenga, J.R.; Hilscher, D.; Birkelund, J. Aug 1979.

In Nuclear chemistry progress report.

The reaction was studied at 8.5 MeV/u. The partially damped energy spectrum for ^{57}Co illustrates the structure. 2 figures. (RWR)

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, THEORETICAL

RADIOACTIVE DECAY

12758 Does the simple statistical model describe delayed neutron emission. The cases of ^{83}As, ^{87}Br, ^{135}Sb and ^{137}I. Prussin, S.G.; Oliveira, Z.M. (California Univ., Berkeley (USA). Dept. of Nuclear Engineering); Kratz, K.-L. (Mainz Univ. (Germany, F.R.). Inst. fuer Kernchemie). *Nucl. Phys., A;* **321**: No. 2, 396-414(4 Jun 1979).

Delayed neutron spectra and branching ratios to excited states in final nuclei calculated with the statistical model are compared to experimental data for the decay of ^{87}Br, ^{137}I, ^{85}As and ^{135}Sb. For the first two precursors, the calculations support the experimental β-strength functions reported previously. For the latter two, it is shown that the statistical model cannot simultaneously reproduce both spectra and branching ratios for any choice of β-strength function when all levels populated by neutron emission are included in the calculations. The comparisons demonstrate that partial widths for neutron emission are not compatible with optical-model transmission coefficients. It is concluded that structure effects in the energy range probed by delayed neutron emission are not averaged out to the extent required by the statistical assumption.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 12760

12759 Spins and parities of low-lying states in ^{77}Kr from the ^{78}Kr(d(pol),t)^{77}Kr reaction. Cadmus, R.R. Jr.; Clegg, T.B.; Ludwig, E.J. (North Carolina Univ., Chapel Hill (USA)); Wender, S.A. (Duke Univ., Durham, NC (USA)). *Nucl. Phys., A;* **319**: No. 1-2, 165-174(30 Apr 1979).

The differential cross sections and vector analyzing powers for the ^{78}Kr(d(pol), t)^{77}Kr reaction leading to low-lying states of ^{77}Kr have been measured at an incident deuteron energy of 15.95 MeV. These data have been compared with distorted-wave Born approximation calculations, as well as with measurements of cross sections and analyzing powers on neighboring nuclei, in order to determine the spins and parities of these states and the spectroscopic factors for the transitions populating them. The ground state of ^{77}Kr, which has been the object of several conflicting spin assignments, has been found to have J/sup π/=5/2$^+$.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 12759

12760 (p,γ) reaction studies on ^{60}Ni. Bokharee, S.; Rimawi, K.; Garg, J.B. (State Univ. of New York, Albany (USA)). *Nucl. Phys., A;* **320**: No. 2, 385-403(21 May 1979).

The γ-ray spectra from the ^{60}Ni(p,γ)^{61}Cu reaction were measured for 27 isolated resonances. From these studies the J/sup π/ assignment of the compound states in ^{61}Cu were made. Moreover, a value for the E1 photon strength function k(E1) = 1.03 x 10^{-9} MeV^{-3} was obtained from seven l = 0 resonances to the 16 low-lying states. This value was then compared with the theoretical estimates of E1 strengths as predicted from the s.p. and giant dipole resonance models. The distribution of partial radiative widths about their mean value was determined from a Monte Carlo technique and was found to be consistent with the Porter-Thomas distribution when the GAMMA/sub γ,ij/ were divided by the E/sub γ/^{5} energy dependence. Values for the coefficients of the correlation R between GAMMA/sub lambda,p/ and GAMMA/sub lambda,γj/; and T between GAMMA/sub lambda,γj/ and GAMMA/sub lambda,γf/ where f not equal to j, were computed with the values R = 0.14 and T = 0.39, respectively. Also the correlation coefficients C(<GAMMA/sub lambda,γj/>, I/sub ^{3}He,d,j// and C(<GAMMA/sub lambda,γf/>, I/sub d,n,f)) yielded the values rho = 0.87 and rho = 0.80 respectively. All these correlations, which are found to be statistically significant, imply that the (p,γ) reaction in ^{60}Ni is partly due to direct capture such as given by valence and doorway state contributions.

MASS, ABUNDANCE, AND BINDING ENERGY

REFER ALSO TO CITATION(S) 12763

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 12758

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 12783

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 12763

12761 Proton spectroscopy of ^{96}Tc from the (^{3}He,d) reaction. Emigh, R.A.; Kraushaar, J.J. (Colorado Univ., Boulder (USA). Nuclear Physics Lab.); Shastry, S. (State Univ. of New York, Plattsburg (USA). Dept. of Physics). *Nucl. Phys., A;* **320**: No. 2, 335-352(21 May 1979).

Energy levels of the even-mass odd nucleus ^{96}Tc have been populated with the ^{95}Mo(^{3}He,d)^{96}Tc reaction at a bombarding energy of 33.6 MeV and with 28 keV resolution (FWHM). Thirty levels were observed below 2.10 MeV excitation. Comparison of experimental angular distributions with DWBA calculations allowed l-value assignments and the extraction of spectroscopic factors for most levels. Over eighty-five percent of the observed spectroscopic strength is located in the low-lying πlg/sub 9/2/-γ2d/sub 5/2/ configuration. A simple residual interaction shell model calculation reproduces the observed low-lying positive-parity multiplet relatively well although the experimental spectrum indicates much configuration mixing is present.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 12761

12762 (HEDL-SA—1969-FP) ENDF/B-5 fission product cross section evaluations. Schenter, R.E.; England, T.R. (Hanford Engineering Development Lab., Richland, WA (USA)). Dec 1979. Contract EY-76-C-14-2170. 33p. (CONF-791223—3). Dep. NTIS, PC A03/MF A01.

From NEANDC specialist meeting on neutron cross sections of fission product nuclei; Bologna, Italy (12 Dec 1979).

Cross section evaluations were made for the 196 fission product nuclides on the ENDF/B-5 data files. Most of the evaluations involve updating the capture cross sections of the important absorbers for fast and thermal reactor systems. This included updating thermal values, resonance integrals, resonance parameter sets, and fast capture cross sections. For the fast capture results generalized least-squares calculations were made with the computer code FERRET. Input for these cross section adjustments included nuclear models calculations and both integral and differential experimental data results. The differential cross sections and their uncertainties were obtained from the CSIRS library. Integral measurement results came from CFRMF and STEK Assemblies 500, 1000, 2000, 3000, 4000. Comparisons of these evaluations with recent capture measurements are shown. 15 figures, 10 tables.

12763 (^{3}He,n) reaction on N=82 targets and even isotopes of neodymium. Alford, W.P. (University of Western Ontario, London (Canada). Dept. of Physics); Anderson, R.E.; Batay-Csorba, P.A.; Emigh, R.A.; Lind, D.A.; Smith, P.A.; Zafiratos, C.D. (Colorado Univ., Boulder (USA). Dept. of Physics). *Nucl. Phys., A;* **321**: No. 1, 45-61(28 May 1979).

Angular distributions of neutrons from the (^{3}He,n) reaction were measured at 25.4 MeV over the angular range 0°-22° for the N=82 targets ^{136}Xe, ^{138}Ba, ^{139}La, ^{142}Nd and ^{144}Sm. In addition, measurements were carried out for the targets ^{144} ^{146} ^{148} ^{150}Nd spanning the transition from spherical to permanently deformed ground states. For each even A,N=82 target, transitions to excited states were observed with considerable L=0 and L=2 strength. Weak transitions to excited states were observed for the ^{144}Nd and ^{139}La targets. Only the ground state transition was observed for the other targets. A careful search was made for the 0$^+$ vibrational states excited in the (t,p) reaction at 0.747 MeV in ^{150}Sm and 0.686 MeV in ^{152}Sm, but these were not populated with measurable strength in the (^{3}He,n) reaction. The Q-value for the ^{144}Sm(^{3}He,n)^{146}Gd(g.s.) reaction was measured to be 0.977+-0.030 MeV, yielding a ground state mass of 145.91832+-0.00003 amu for ^{146}Gd.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

12764 Coulomb excitation study of ^{182} ^{184} ^{186}W isotopes. Hubert, P. (Bordeaux-1 Univ., 33 - Gradignan (France). Centre d'Etudes Nucleaires); Roulet, C.; Sergolle, H.; Colombani, P.; Lagrange, J.M. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire); Vanhorenbeeck, J. (Brussels Univ. (Belgium)); Johnson, N.R. (Oak Ridge National Lab., TN (USA)). *Nucl. Phys., A;* **321**: No. 1, 213-221(28 May 1979).

Coulomb excitation measurements have been performed with 340 MeV ^{84}Kr projectiles on ^{182}W, ^{184}W and ^{186}W. The ground state bands up to the 12$^+$ state in ^{182}W and to the 10$^+$ states in the two other isotopes have been populated. B(E2) values, extracted from the relative Coulomb excitation yields, are compared with rigid-rotor model calculations. Properties of the ground state bands are compared with less neutron-rich even tungsten isotopes and discussed within the decoupling model.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 12763, 12764

12765 (ORO—5172-14, pp 3-8) **Nucleon exchange and A/Z equilibration in interactions of 8.3 MeV/u ^{56}Fe ions with ^{56}Fe, ^{165}Ho and ^{209}Bi.** Breuer, H. (Univ. of Maryland, College Park); Glagola, B.G.; Viola, V.E.; Wolf, K.L.; Mignerey, A.C.; Birkelund, J.R.; Hilscher, D.; Huizenga, J.R.; Schroeder, U.; Wilcke, W.W. Aug 1979.

In Nuclear chemistry progress report.

Charge and mass distributions were measured for the products formed in damped collision processes in three heavy-ion systems of widely differing target-projectile mass asymmetries and A/Z values. Excellent resolution for Z and A permitted the determination of precise values for A-bar, Z-bar, σ/sub A/^{2}, and σ/sub Z/^{2}. The Z-bar and A-bar results show that charge equilibration develops gradually with increasing energy loss. Hence, for very asymmetric systems, an equilibrium in A/Z is not achieved until the reaction is almost totally damped, a situation requiring comparatively long interaction times. The relationship between σ/sub Z/^{2} and σ/sub A/^{2} supports a correlated nucleon diffusion mechanism for interaction times sufficiently long that the limiting A-bar/Z-bar value has been reached. This result is consistent with similar time scales for evolution of the correlations in the nucleon exchange, the equilibration of A/Z, and the energy dissipation. The energy loss time scale leads to a interaction time of (3 to 8) x 10^{-22} sec at 100 MeV energy loss for the non-sticking and sticking conditions, at which time the correlations in nucleon exchange and A/Z ratio seem to be close to steady-state values. 3 figures. (RWR)

12766 (ORO—5172-14, pp 24-27) **Neutron emission in damped collisions.** Hilscher, D. (Rochester Univ., NY); Birkelund, J.; Schroeder, U.; Wilcke, W.; Huizenga, J.R.; Wolf, K.L.; Mignerey, A.C.; Breuer, H.; Viola, V.E. Aug 1979.

In Nuclear chemistry progress report.

Neutron and alpha-particle emission were measured for the damped collision and fusion-fission products resulting from the bombardment of ^{165}Ho with 8.5-MeV/u ^{56}Fe ions. These experiments involved the measurement of neutrons and light ions coincident with Fe-like damped collision products. Neutrons were measured with NE-213 detectors. Mean neutron multiplicities and energies are tabulated. From an examination of the resultant c.m. neutron kinetic energy spectra at several angles, it is concluded that both light and heavy reaction partners exhibit equal nuclear temperatures. This result is consistent with complete equilibration of excitation energy during the lifetime of the relatively short-lived dinuclear complex formed in the interaction. The high-energy tail of these spectra leads to an estimate of $< 5\%$ for the contribution from pre-equilibrium neutron emisson. Both the total neutron multiplicity and the ratio of the heavy-to-light fragment multiplicities are shown. 2 figure, 1 table. (RWR)

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

REFER ALSO TO CITATION(S) 12783

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 12770

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 12765

12767 (JAPFNR—486) **Evaluation of neutron nuclear data for ^{243}Cm.** Igarasi, S.; Nakagawa, T. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). 1979. 41p. (In English and Japanese). (JAERI-M—8342; PNC-J—250-79-17). Dep. NTIS (US Sales Only), PC A03/MF A01.

Work performed under United States-Japanese Fast Reactor Exchange Program.

Evaluation of neutron nuclear data for ^{243}Cm is performed in the energy range of thermal to 20 MeV. Quantities evaluated are total, elastic and inelastic scattering, fission, capture, (n,2n) and (n,3n) reaction cross sections, resonance parameters, anti ν, anti μ/sub L/, and angular distributions of emitted neutrons. Resonance parameters are recommended below 275 eV. Statistical and optical model calculations are made above 275 eV. The optical potential parameters used in the calculations are obtained by using the experimental total cross section of ^{241}Am. Fission cross section obtained from systematics and the evaluated data of ^{244}Cm. The results are compiled in the ENDF/B format.

12768 (ORO—5172-14, pp 14-20) **Investigation of damped collisions in the ^{56}Fe + ^{209}Bi reaction.** Breuer, H. (Univ. of Maryland, College Park); Glagola B.G.; Viola, V.E.; Mignerey, A.C.; Wolf, K.L.; Birkelund J.R.; Hilscher, D.; Huizenga, J.; Schroeder, U.; Wilcke, W.W. Aug 1979.

In Nuclear chemistry progress report.

The reaction of 385- and 480-MeV ^{56}Fe with ^{209}Bi was analyzed. Charge distributions of projectile-like fragments were measured with discrete Z resolution as functions of angle and total kinetic energy loss. Angle-integrated cross sections for the projectile-like fragments are shown as functions of E/sub LOSS/. Both energy distributions show a strong peak at low energy losses, followed by a rather flat distribution with a second maximum at high E/sub LOSS/. It is deduced that the strongly damped events separate from a highly deformed configuration. The E/sub LOSS/ scale can be converted into an orbital angular momentum scale. Analysis showed that Z-bar and σ/sub Z/^{2} are independent of scattering angle. The drift in Z is in qualitative agreement with the predictions from calculations of potential energy surfaces from a liquid drop model. An example is shown for l = 0. 4 figures. (RWR)

12769 Q- and Z-dependence of angular momentum transfer in deeply inelastic collisions of ^{86}Kr with ^{209}Bi. Dyer, P.; Puigh, R.J.; Vandenbosch, R. (Washington Univ., Seattle (USA)); Thomas, T.D. (Oregon State Univ., Corvallis (USA)); Zisman, M.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.); Nunnelley, L. (Chemeketa Community College, Salem, OR, USA). *Nucl. Phys., A;* **322**: No. 1, 205-236(11 Jun 1979).

The dependence of the in-plane and out-of-plane angular correlations of fragments from fissioning heavy products on the kinetic energy and Z of the light reaction partner have been measured. From the dependence of the angular correlations on Q-value and hence energy loss, together with existing data from which the total angular-integrated cross section as a function of energy loss can be extracted, the dependence of the angular momentum transferred to the heavy product on the initial orbital angular momentum or impact parameter has been determined. The resulting dependence is qualitatively consistent with the sticking limit for a reaction intermediate of touching deformed fragments. More specific nuclear models generally underestimate the angular momentum transfer, although the one-body proximity-friction model accounts for the major fraction of the angular momentum transfer. A recent model incorporating both one-body proximity friction and collective excitations accounts quite well for the observed angular momentum transfer. The Z-dependence of the anisotropy shows the importance of angular momentum fractionation for the less probable events, where the Z of the fissioning system is appreciably less than that of the target. The transferred angular momentum is shown to be fairly strongly aligned along the perpendicular to the reaction plane, with alignment values of 0.6 to 0.8. The component of angular momentum not along the perpendicular to the reaction plane is found to be primarily oriented perpendicular rather than parallel to the recoil directions. The absolute fission probabilities are found to be qualitatively consistent with J-dependent calculations using the J-values deduced from the angular correlations.

12770 ^{194}Pt(^{12}C,^{12}C')reaction and the triaxial-rotor model. Baker, F.T.; Scott, A. (Georgia Univ., Athens (USA)); Cleary, T.P.; Ford, J.L.C.; Gross, E.E.; Hensley, D.C. (Oak Ridge National Lab., TN (USA)). *Nucl. Phys., A;* **321**: No. 1, 222-230(28 May 1979).

Elastic and inelastic scattering differential cross sections for the ^{194}Pt(^{12}C,^{12}C')reaction at a bombarding energy of 78 MeV have been measured. Data have been obtained for 0^+,2^+,4^+, and 2^+', states in ^{194}Pt. The data have been analyzed using a rigid asymmetric-rotor model in coupled-channels reaction calculations. It is found that satisfactory fits to all data can be obtained but only if the hexadecapole deformation is included in the asymmetric-rotor model.

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 12769

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 12773, 12785

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

RADIOACTIVE DECAY

12771 (HEDL-SA—1764) **^{239}Pu decay heat evaluation.** Schmittroth, F.; Schenter, R.E. (Hanford Engineering Development Lab., Richland, WA (USA)). Jan 1979. Contract EY-76-C-14-2170. 5p. (CONF-790816—76). Dep. NTIS, PC A02/MF A01.

From International meeting on fast reactor safety technology; Seattle, WA, USA (19 Aug 1979).

Based on recent measurements, a new evaluation for the decay heat from ^{239}Pu was obtained. The results are important for ^{239}Pu-fueled fast breeder reactors where decay heat values have previously been obtained from summation calculations. The evaluation was, in part, support for a revised ANS decay heat standard for light water reactors. The same statistical methods used previously in the evaluation of decay heat for the thermal fission of ^{235}U were used here. The new evaluation is typically a few percent higher than values previously calculated from ENDF/B-IV. Final evaluated uncertainties are $\sim$ 4% (1σ) and reflect discrepancies in the measurements that are shown to exist. 8 references.

NUCLEAR REACTIONS AND SCATTERING

12772 (ORO—5172-14, pp 36-39) **Spectra of light ions in coincidence with angle-correlated fission fragments in the $^{16}O + ^{238}U$ reaction at 20 MeV/u.** Awes, T.C. (Michigan State Univ., East Lansing); Dyer, P.; Gelbke, C.K.; Back, B.B.; Mignerey, A.C.; Wolf, K.L.; Breuer, H.; Viola, V.E. Aug 1979.

In Nuclear chemistry progress report.

Fission yields for H and He ions are shown as a function of fission fragment correlation angle; the probability for emission of energetic light particles is high for both central and peripheral collisions. The energy spectra observed at 14° for both types of collision are compared. It is found that light-ion emisson in this reaction is dominated by pre-equilibrium process, and involves large momentum transfers to the target nucleus. 2 figures (RWR)

12773 (ORO—5172-14, pp 40-42) **Studies of the $^{4}He + ^{233}U$ reaction between 12 and 35 MeV/u.** Viola, V.E. (Univ. of Maryland, College Park); Glagola, B.G.; Read, S.M.; Meyer, W.G. Aug 1979.

In Nuclear chemistry progress report.

Experimental fission fragment angular correlations at 140 MeV are compared with predictions based on the intranuclear cascade model. The calculations reproduce the features of the experimental data qualitatively; the no-breakup assumption for alpha-particle cascades provides a better fit than one allowing breakup. Effects of two-body energy dissipation must be incorporated into models hoping to describe collisions induced by complex nuclei above 10 MeV/nucleon. 1 figure. (RWR)

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 12772, 12773

12774 (ORNL/TM—7148) **Measurement of the average number of prompt neutrons emitted per fission of ^{235}U relative to ^{252}Cf for the energy region 500 eV to 10 MeV.** Gwin, R.; Spencer, R.R.; Ingle, R.W.; Todd, J.H.; Weaver, H. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 37p. (ENDF—289). Dep. NTIS, PC A03/MF A01.

The average number of prompt neutrons emitted per fission ν/sub p/-bar(E), was measured for ^{235}U relative to ν/sub p/-bar for the spontaneous fission of ^{252}Cf over the neutron energy range from 500 eV to 10 MeV. The samples of ^{235}U and ^{252}Cf were contained in fission chambers located in the center of a large liquid scintillator. Fission neutrons were detected by the large liquid scintillator. The present values of ν/sub p/-bar(E) for ^{235}U are about 0.8% larger than those measured by Boldeman. In earlier work with the present system, it was noted that Boldeman's value of ν/sub p/-bar(E) for thermal energy neutrons was about 0.8% lower than obtained at ORELA. It is suggested that the thickness of the fission foil used in Boldeman's experiment may cause some of the discrepancy between his and the present values of ν/sub p/-bar(E). For the energy region up to 700 keV, the present values of ν/sub p/-bar(E) for ^{235}U agree, within the uncertainty, with those given in ENDF/B-V. Above 1 MeV the present results for ν/sub p/-bar(E) range about the ENDF/B-V values with differences up to 1.3%. 6 figures, 1 table.

12775 (ORO—5172-14, pp 28-32) **Linear momentum transfer in the $^{16}O + ^{238}U$ reaction.** Viola, V.E. (Univ. of Maryland, College Park); Breuer, H.; Back, B.; Wolf, K.L.; Mignerey, A.C.; Gelbke, C.K.; Awes, T.C.; Dyer, P. Aug 1979.

In Nuclear chemistry progress report.

The $^{16}O + ^{238}U$ reaction was investigated at 8.5 and 20 MeV/u to study the global features of light heavy-ion reactions as a function of bombarding energy. Linear momentum transfer distributions were measured by means of the fission fragment angular correlation technique. Data for the angular correlation function are shown, and the kinetics of the reaction is discussed. 1 figure. (RWR)

12776 (ORO—5172-14, pp 33-35) **Studies of projectile-like fragments in the $^{16}O + ^{238}U$ reaction at 20 MeV/u.** Dyer, P. (Michigan State Univ., East Lansing); Awes, T.C.; Gelbke, C.K.; Back, B.B.; Mignerey, A.C.; Wolf, K.L.; Breuer, H.; Viola V.E.; Meyer, W.G. Aug 1979.

In Nuclear chemistry progress report.

Projectile residues were studied in coincidence with angle-correlated fission fragments resulting from reactions of 20-MeV/u ^{16}O ions on ^{238}U. Distributions of the missing parallel momentum are shown for different projectile residues, and the dependence of the average parallel recoil momentum on the average parallel momentum of the projectile residue is plotted. 2 figures. (RWR)

NUCLEAR THEORY

NUCLEAR MATTER

12777 **Role of tensor forces in Fermi liquid theory.** Baeckman, S.-O.; Sjoeberg, O. (Aabo Akademi, Turku (Finland). Dept. of Physics); Jackson, A.D. (State Univ. of New York, Stony Brook (USA). Dept. of Physics). *Nucl. Phys., A;* **321**: No. 1, 10-24(28 May 1979).

The effect of tensor forces on the Fermi liquid parameters in nuclear matter is studied. The usual stability conditions in the $sigma_1 x sigma_2$ and $sigma_1 x sigma_2 tau_1 x tau_2$ channels are found to be appreciably modified by tensor forces. Fermi liquid parameters are presented for the Reid soft-core potential corrected for the proper inclusion of tensor forces.

12778 **Pion condensation and the sigma-model in liquid neutron matter.** Dautry, F.; Nyman, E.M. (State Univ. of New York, Stony Brook (USA). Dept. of Physics). *Nucl. Phys., A;* **319**: No. 3, 323-348(7 May 1979).

The nature of the ground state of neutron matter at neutron star densities is discussed, starting from the linear sigma-model Lagrangian. It is found that there is a possibility of a new, previously unknown, type of condensation, which involves coherent, non-vanishing expectation values of the neutral meson fields of the theory, the sigma and π^0 fields. The $sigma\pi^0$ condensate would, like normal neutron matter, develop its own π^0 condensate. It is shown that the most general, translationally invariant, condensate is a combined $sigma\pi^0$ and π^- condensate with arbitrary, independent, wave numbers. The wave vectors of the condensates are determined by a minimization process, and are found to be non-vanishing and perpendicular. This paper leans heavily on the linear sigma model. However, the neutral condensate is a general consequence of chiral symmetry, and can thus also be obtained e.g. from Weinberg's Lagrangian.

NUCLEAR REACTIONS AND SCATTERING

12779 (ANL/NDM—49) **Some comments on resolution and the analysis and interpretation of experimental results from differential neutron measurements.** Smith, D.L. (Argonne National Lab., IL (USA)). Nov 1979. Contract W-31-109-ENG-38. 33p. Dep. NTIS, PC A03/MF A01.

Effects of finite resolution in differential neutron measurements are examined. General procedures for deriving the experimental resolution functions from a knowledge of the experimental parameters are presented. Problems encountered in the comparison of different data sets, when the measured cross section is known to fluctuate with energy, are discussed. The objective is to encourage closer attention to the matter of resolution by experimenters, evaluators and users of neutron nuclear data.

12780 (LBL—8407) **Non-equilibrium statistical mechanical approach for describing heavy ion reactions.** Sventek, J.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1978. Contract W-7405-ENG-48. 198p. Dep. NTIS, PC A09/MF A01.

Thesis.

With the availability of heavy-ion projectiles ($A > 4$) at low to intermediate energies ($4 < E/A < 10$), products showing various stages of relaxation for certain macroscopic variables (center-of-mass energy, orbital angular momentum, etc.) were produced in various reactions. The distributions for these macroscopic variables showed a correlation between the stage of relaxation reached and the net amount of mass transfer which had occurred in the reaction. There was also evidence that there was an asymmetry in the number of net transfers necessary for complete relaxation between stripping and pickup reactions. A model for describing the time-evolution of these reactions was formulated, the keystone of which is a master-equation approach for describing the time-dependence of the mass-asymmetry. This, coupled with deterministic equations of motion for the other macroscopic coordinates in the reaction lead to calculated distributions which provide an excellent qualitative description of these reactions, and, in some cases, quantitatively reproduce the experimental data quite well. 61 figures, 2 tables.

12781 (LBL—9902) **Nuclear collisions at several tens of MeV per nucleus.** Randrup, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1979. Contract W-7405-ENG-48. 34p. Dep. NTIS, PC A03/MF A01.

Nuclear beams with energies of several tens of MeV per nucleon will soon be available at a number of research centers around the world. Such beams offer a tool for probing new aspects of nuclear structure and dynamics. As the energy is raised models and concepts developed for the relatively well studied lower energy domain will be pressed to their limits and are likely to grow obsolete as novel phenomena enter the scene. The theory of ordinary damped collisions is considered; the testing of such theories is one important aspect of the research with higher beam energies. Another is the

search for truly novel phenomena, and some more speculative material on that aspect are given. 15 references.

12782 (ORO—3992-376) **Simple spacetime description of high energy hadron-nucleus collisions.** Chao, W.; Chiu, C.B.; He, Z.; Tow, D.M. (Academia Sinica, Beijing (China). Inst. of High Energy Physics; Academia Sinica, Beijing (China). Inst. of Theoretical Physics; Texas Univ., Austin (USA). Center for Particle Theory). Nov 1979. Contract EY-76-S-05-3992. 15p. Dep. NTIS, PC A02/MF A01.

A simple space-time description of high-energy hadron-nucleus collisions is presented. The model is based on the two-sheet description of soft multiparticle production in hadron-hadron collisions, and can be formulated in a parton framework. This zero-parameter model agrees well with the general features of hadron-nucleus data. 3 figures.

12783 **Exact finite range calculations of light-ion induced two-neutron transfer reactions.** Takemasa, T.; Tamura, T.; Udagawa, T. (Texas Univ., Austin (USA). Dept. of Physics). *Nucl. Phys., A;* **321**: No. 2, 269-294(4 Jun 1979).

Exact finite-range (EFR) distorted-wave Born approximation calculations were performed for light-ion induced two-neutron transfer reactions, by using a technique to calculate the form factors rather fast. The use of this method made it possible to carry out calculations even when realistic light-ion wave functions and multiconfigurational two-neutron wave functions were used and large transferred angular momenta were considered. It was found that, at lower bombarding energies, the predictions of the EFR and zero-range calculations agree very closely both in angular distributions and relative magnitudes of the cross sections, though they differ significantly in absolute magnitude. As the bombarding energy increases, the discrepancy between the predicted absolute magnitude becomes still larger, and noticeable differences are seen even in relative cross sections. For all the energies considered, the EFR calculations predicted the absolute magnitudes of the experimental cross sections to within a factor of several units.

12784 **P-wave absorptive and dispersive effects on pion-nucleus scattering.** Brown, G.E. (State Univ. of New York, Stony Brook, NY); Jennings, B.K.; Rockmore, R.M. pp 614-615 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Pion-nucleus scattering which derives from nuclear matter considerations in which the delta-1236 isobar plays a fundamental role is extended to include the effects of p-wave absorption and dispersion. Pion scattering on carbon-12 and oxygen-16 are noted. 3 references. (JFP)

NUCLEAR MODELS

12785 **Theory of high-energy heavy-ion collisions.** Nix, J.R. (Los Alamos Scientific Lab., NM (USA)). *Prog. Part. Nucl. Phys.;* **2**: 237-284(1979).

In describing high-energy, heavy-ion collisions four different theoretical approaches, all based on the classical approximation, are considered. Of these approaches, relativistic fluid dynamics and relativistic two-fluid dynamics are macroscopic, and the basic input is the nuclear equation of state; whereas the relativistic intranuclear cascade and the nonrelativistic many-body equations of motion approaches are microscopic, and the basic inputs are the nucleon-nucleon and pion-nucleon cross sections and the nucleon-nucleon potential, respectively. Each of the approaches is used to caiculate the double differential cross section for outgoing charged particles from the reaction $^{20}Ne + {}^{238}U$ at a laboratory bombarding energy per nucleon of 250 MeV, and the results are considered and compared. 292 references.

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

REFER ALSO TO CITATION(S) 12876

12786 (AD-A—069788) **Electronic stopping power calculations. Annual summary report no. 1, 1 Jun 1978-31 May 1979.** Brennan, J.G.; Land, D.J. (Catholic Univ. of America, Washington, DC). 4 Jun 1979. Contract N00014-78-C-0515. 5p. NTIS, PC A02/MF A01.

The electronic stopping power values for projectiles whose atomic number lies between 6 and 92, incident on targets from Z = 1 to Z = 102 has been calculated using Hartree-Fock wave functions within the Firsov context. Relativistic corrections have been included. Comparisons of these stopping power values with all existing experimental values are made. Part of this work has been published and the rest will be published as a technical report. An outline of proposed study of the coming year is presented.

12787 (LA—8176-MS) **MCNP, a general Monte Carlo code for neutron and photon transport: a summary.** Thompson, W.L. (Los Alamos Scientific Lab., NM (USA)). Dec 1979. Contract W-7405-ENG-36. 15p. Dep. NTIS, PC A02/MF A01.

The general-purpose Monte Carlo code MCNP can be used for neutron, photon, or coupled neutron-photon transport, including the capability to calculate eigenvalues for critical systems. The code treats an arbitrary three-dimensional configuration of materials in geometric cells bounded by first- and second-degree surfaces and some special fourth-degree surfaces (elliptical tori).

12788 (SLAC-PUB—2422) **Radiation spectra and angular distribution of emitted quanta for planar channelled particles: dependence on particle energy.** Kheifets, S.; Knight, T. (Stanford Linear Accelerator Center, CA (USA)). Oct 1979. Contract EY-76-C-03-0515. 30p. (PEP-NOTE—323; CONF-791226—1). Dep. NTIS, PC A03/MF A01.

From APS electron and atomic physics meeting; Houston, TX, USA (10 Dec 1979).

Using a method of calculating the radiation characteristics for the motion in an arbitrary one-dimensional potential, developed in the previous paper, we look here for the maximum in the number of emitted photons as a function of particle energy for different amplitudes of oscillations, divergence angles in a plane parallel to the trapping crystal planes and harmonic numbers. The problem is treated in the classical approximation. A numerical example is given for positron channelling in the (1,1,0) direction of a Silicon crystal. The influence of the refraction index is discussed briefly.

NEUTRON INTERACTIONS WITH MATTER

REFER ALSO TO CITATION(S) 11885, 12787, 12876

12789 (DOE/TIC—11075) **Integral cross-section measurements on fission-products in fast neutron fields.** Harker, Y.D.; Anderl, R.A. (EG and G Idaho, Inc., Idaho Falls (USA)). 1979. Contract AC07-76ID01570. 14p. Dep. NTIS, PC A02/MF A01.

An integral measurement program is in progress at the Idaho National Engineering Laboratory (INEL). The major emphasis in this program is on neutron capture cross-section measurements in the Coupled Fast Reactivity Measurement Facility (CFRMF) and in the Experimental Breeder Reactor II (EBR-II). The CFRMF measurements utilize activation techniques to arrive at integral capture cross-section data and similarly the EBR-II measurements utilize isotope dilution mass spectrometry. This paper reviews the status of the INEL measurement program and compare measured data with the ENDF/B derived integrals. Briefly, the results of those comparisons show that the ENDF/B IV data are the order of 25% greater than the CFRMF.

12790 (PNL-SA—6603) **Measuring neutron dose and quality factors with tissue equivalent proportional counters.** Brackenbush, L.W.; Endres, G.W.R.; Faust, L.G. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1978. Contract EY-76-C-06-1830. 11p. (CONF-780612—10; IAEA-SM—229/52). Dep. NTIS, PC A02/MF A01.

From Symposium on advances in radiation protection monitoring; Stockholm, Sweden (26 Jun 1978).

The methods used to obtain absolute neutron dose measurements and quality factor determination from the tissue equivalent proportional counter (TEPC) are reviewed. Exposure to nearly monoenergetic neutrons with energies from 200 keV to 7.5 MeV indicate that the absorbed dose due to fast neutrons measured by the TEPC averaged 3% higher, with a standard deviation (1 σ) of 9%, than the tissue kerma calculated from neutron fluence measurements. The absorbed dose due to fast neutrons measured by the TEPC agreed within 0.6% of the calculated tissue kerma for a PuBe neutron source, whose neutron yield was determined within 2% by the United States National Bureau of Standards. Data are presented which show the TEPC measures quality factors accurately enough for health physics purposes for neutrons with energies between 200 keV and 5 MeV.

12791 **180 degree n-p cross sections for fast neutron measurements with counter telescopes.** Drosg, M.; Drake, D.M. (Los Alamos Scientific Lab., NM (USA)). *Nucl. Instrum. Methods;* **160**: No. 1, 143-145(1 Mar 1979).

The validity of phase shift predictions for the 180° cross sections of $^{1}H(n,n)^{1}H$ needed in recoil-proton neutron counter telescope measurements was tested experimentally at 25.30 and 31.06 MeV. For these two energies absolute center-of-mass cross sections of (34.6+-0.9)mb/sr and (29.1+-1.0)mb/sr, respectively, were obtained by comparing the proton yields in a counter telescope with the neutron flux measured with a calibrated time-of-flight system and by subsequent normalization to the well established value of 62.9mb/

sr for neutrons of 12.83 MeV. Contrary to previous counter telescope measurements of neutrons from the $^3H(d,n)^4He$ reaction with energies above 20 MeV, these results are consistent with phase shift predictions. Too low values of older measurements may have been caused by a background from extraneous protons, e.g., originating from the water spray used to cool the tritium target.

MEDICAL PHYSICS

RADIATION SOURCE CALIBRATION AND STANDARDIZATION

12792 (BNL—51066) **Safety and Environmental Protection Division. Progress report, January 1, 1976-December 31, 1978.** (Brookhaven National Lab., Upton, NY (USA)). Oct 1979. Contract EY-76-C-02-0016. 67p. Dep. NTIS, PC A04/MF A01.

Dosimetry and radiological physics studies during 1976 and 1977 at BNL are described. (GHT)

DOSIMETRY

12793 (UCRL—82655) **Polyurethane as a base for a family of tissue equivalent materials.** Griffith, R.V. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1980. Contract W-7405-ENG-48. 6p. (CONF-800304—7). Dep. NTIS, PC A02/MF A01.

From 5. international congress of the International Radiation Protection Association; Jerusalem, Israel (8 Mar 1980).

Polyurethane was used as a base material for a wide variety of tissue simulating applications. The technique in fabrication is similar to that of epoxy, however, the end products are generally more flexible for use in applications where flexibility is valuable. The material can be fabricated with relatively small laboratory equipment. The use of polyurethane provides the dosimetrist with the capability of making specific, accurate, on-the-spot tissue equivalent formulations to meet situations which require immediate calibration and response.

12794 (UCRL—82658) **Systematic approach to personnel neutron monitoring.** Griffith, R.V.; Hankins, D.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1980. Contract W-7405-ENG-48. 9p. (CONF-800304—8). Dep. NTIS, PC A02/MF A01.

From 5. international congress of the International Radiation Protection Association; Jerusalem, Israel (8 Mar 1980).

NTA film and albedo detectors represent the major portion of personnel dosimeters now used for occupational neutron monitoring. However, recent attention to the spectral response of these systems has demonstrated the need for detectors that have a better match to the fields being monitored. Recent developments in direct recoil track etch dosimeters present some intriguing alternatives, and careful use of ^{237}Np fission fragment detectors offers the advantage of a good dose equivalent spectral match. Work continues on a number of other new detector mechanisms, but problems with sensitivity, energy response, gamma interference, etc., continue to prevent development of most mechanisms into viable personnel dosimeters. Current dosimeter limitations make a systematic approach to personnel neutron monitoring particularly important. Techniques have been developed and tested, using available portable survey instruments, that significantly improve the quality of dosimeter interpretation. Even simple spectrometry can be done with modest effort, significantly improving the health physicists ability to provide accurate neutron monitoring.

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 11477

12795 **Surprising effectiveness of the Migdal-Kadanoff renormalization scheme.** Swendsen, R.H.; Zia, R.K.P. (Brookhaven National Lab., Upton, NY). *Phys. Lett.;* **69**: No. 6, 382-384(22 Jan 1979).

Alternatives to the simple Migdal-Kadanoff renormalization-group method are investigated by use of variational techniques. Although the free energy is improved (increased), the critical properties are found to be surprisingly poor. 2 figures, 1 table.

SUPERCONDUCTIVITY

GENERAL THEORY

12796 (ISM—258) **Vortices in superconducting films.** Clem, J.R. (Ames Lab., IA (USA)). 1979. Contract W-7405-ENG-82. 7p. (CONF-791151—1). Dep. NTIS, PC A02/MF A01.

From Inhomogeneous superconductors conference; Berkeley Springs, WV, USA (1 Nov 1979).

The local magnetic flux density and electrical current density generated by a vortex in a superconducting film is calculated approximately using an extension of Pearl's method. The results apply to arbitrary ratios of the film thickness to the penetration depth and reduce to Pearl's thin-film and semi-infinite results in the appropriate limits. In addition, the vanishing of the order parameter on the vortex axis is accounted for by a simple model which removes the London-model divergences of the flux density and supercurrent density and leads to a physically correct description in the vortex core. The results are then applied to a calculation of the interaction energy of vortex-vortex and vortex-antivortex pairs.

12797 **Stability of the superconductive operating mode in high current-density devices.** Wipf, S.L. (Los Alamos Sci Lab, NM). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 379-382(Jan 1979).

The superconductive operating mode represents a thermal equilibrium that can tolerate a certain amount of disturbance before it is lost. The basin of attraction (BOA), in many ways equivalent to a potential well, is a measure of the size of disturbance needed to lift the device from the superconductive into a resistive operating mode. The BOA for a simple geometry is calculated and discussed. Experimental results are reported, showing how the concept is used to gain information on the disturbances occurring in a superconducting device.

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 12187, 12192, 12193, 12194, 12195, 12206

12798 (ISM—256) **Magnetic field dependence of the pair potential in inhomogeneous superconductors.** Finnemore, D.K.; Hsiang, T.Y. (Ames Lab., IA (USA)). 1979. Contract W-7405-ENG-82. 5p. (CONF-791151—2). Dep. NTIS, PC A02/MF A01.

From Inhomogeneous superconductors conference; Berkeley Springs, WV, USA (1 Nov 1979).

The depairing effects of an applied magnetic field have been studied for inhomogeneous superconductors by measuring the critical currents of SNS junctions. Critical currents are found to decrease exponentially with increasing H over 3 orders of magnitude change in I/sub c/. If the depairing parameter is taken to be α = D/sub N/eH/c, one finds a diffusivity of 0.22 m^2s^{-1} which agrees with the value from resistivity to an accuracy of about 30%.

THEORETICAL PHYSICS

STATISTICAL PHYSICS AND THERMODYNAMICS

REFER ALSO TO CITATION(S) 12877, 12887

12799 (UCID—18492) **Treatise on Planckian spectra showing sensitivity of measured blackbody temperatures to background radiation.** Del Grande, N.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Dec 1979. Contract W-7405-ENG-48. 15p. Dep. NTIS, PC A02/MF A01.

This study approximates the Planckian integral. It applies the power-law thermal model to analyze the behavior of blackbody sources. The spectral intensity, at energy E, varies as the temperature kT raised to the power n = E/kT. A hypothetical background is introduced at E = 12 kT which doubles the blackbody signal recorded at this energy. This causes the inferred temperature and source intensity to be respectively 6% and 26% too high. This occurs since typical measurement methods assume a Planckian spectral shape.

MATHEMATICAL PHYSICS

REFER ALSO TO CITATION(S) 12877

12800 (CONF-790902—, pp 81-84) **Implementation of a linear system solver.** Sanderson, J.G. (Los Alamos Scientific Lab., NM). 1979.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

The use of a line relaxation scheme to solve a five-point difference approximation to the radiation diffusion equation is discussed. The matrix solver has been vectorized for the CRAY-1. The use of a column convergence test and column iteration decision to speed computation are also discussed. In addition, the implementation of a multigrid routine in one of two dimensions is mentioned. 3 figures, 1 table.

12801 (SAND—79-2233C) **Solving structures problems iteratively with a shifted incomplete Cholesky preconditioning.** Manteuffel, T.A. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 21p. (CONF-791201—3). Dep. NTIS, PC A02/MF A01.

From 4. IRIA international symposium on computing methods in applied science and engineering; Versailles, France (10 Dec 1979).

A technique for solving the large sparse symmetric linear systems that arise from the application of finite element methods is described. The technique combines an incomplete factorization method called the shifted incomplete Cholesky factorization with the method of generalized conjugate gradients. The shifted incomplete Cholesky factorization produces a splitting of the matrix A that is dependent upon a parameter α. It is shown that, if A is positive definite, then there is some α for which this splitting is possible and that this splitting is at least as good as the Jacobi splitting. The method is shown to be more efficient on a set of test problems than either direct methods of explicit iteration schemes. 4 figures, 1 table.

12802 **Existence and uniqueness for similarity solutions of one-dimensional multi-phase Stefan problems.** Wilson, D.G. (Union Carbide Corp., Oak Ridge, TN). *SIAM J. Appl. Math.;* **35**: No. 1, 135-147(Jul 1978).

The similarity solution of a multi-phase one-dimensional Stefan problem gives rise to a system of nonlinear equations for the coefficients of $\sqrt{t}$ which determine the speeds of the several interphase boundaries. The existence and uniqueness of a solution to this system are established, provided that a certain reasonable order relation exists among the boundary values. In addition, a nonexistence result is established for the situation when most of the relations are satisfied but one is seriously violated. This result implies the existence of physically plausible Stefan problems with constant boundary values for which there do not exist similarity solutions. 4 figures.

FUSION ENERGY

PLASMA RESEARCH

REFER ALSO TO CITATION(S) 12869

PLASMA CONFINEMENT AND HEATING

REFER ALSO TO CITATION(S) 12821

12803 (COO—5125-1) **Studies of rf tandem mirror heating. Annual progress report, October 1, 1978-September 30, 1979.** Kesner, J.; Emmert, G.A.; Howard, J.E. (Wisconsin Univ., Madison (USA)). May 1979. Contract ET-79-S-02-5125. 59p. Dep. NTIS, PC A04/MF A01.

During the first 8 months of this project the questions of primary interest have been centered on the use of Ion Cyclotron Resonance Frequency range (ICRF) wave heating in tandem mirror plugs. In particular we have been engaged in examining the following questions: (1) the use of ICRF to provide partial plug fueling in a tandem mirror, (2) the effect on spatial density and ambipolar potential distribution of the location of the wave-particle resonance zone, (3) dynamic stabilization of the Drift Cyclotron Loss-Cone instability due to the imposed ICRF.

12804 (PPPL—1618) **Energy confinement comparison of ohmically heated stellarators to tokamaks.** Chu, T.K.; Lee, Y.C. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Dec 1979. Contract EY-76-C-02-3073. 19p. Dep. NTIS, PC A02/MF A01.

An empirical scaling prescribes that the energy confinement time in ohmically heated stellarators and tokamaks is proportional to the internal energy of the plasma and the minor radius, and inversely proportional to the current density. A thermal-conduction energy transport model, based on a heuristic assumption that the effective momentum transfer in the radial direction is proportional to the classical parallel momentum transfer which results in ohmic heating, is used to explain this scaling.

12805 (SAN—0034/202-1) **Production of iterated leakage from a mirror machine using iron bars. Final report, June 15, 1972-July 31, 1975.** Forrester, A.T.; Crow, J.T. (California Univ., Los Angeles (USA)). 19 Jun 1979. Contract EY-76-S-03-0034-202. 36p. Dep. NTIS, PC A03/MF A01.

It is a goal of this program to split the ion flux out of a mirror machine into a sufficiently large number of beams that the space charge in each is small and easily controlled. A means of doing this is illustrated schematically. A perforated iron slab is placed in the throat of the mirror machine in the hope that the field at the holes in the ion will be sufficiently weakened that particles will escape through these holes before they can drift into the escape cones corresponding to other portions of the mirror throat. (MOW)

12806 (UCID—18505) **Tandem mirror thermal barrier experimental program plan.** Coensgen, F.H.; Drake, R.P.; Simonen, T.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Jan 1980. Contract W-7405-ENG-48. 29p. Dep. NTIS, PC A03/MF A01.

This report describes an experimental plan for the development of the Tandem Mirror Thermal Barrier. Included is: (1) a description of thermal barrier related physics experiments; (2) thermal barrier related experiments in the existing TMX and Phaedrus experiments; (3) a thermal barrier TMX upgrade; and (4) initiation of investigations of axisymmetric magnetic geometry. Experimental studies of the first two items are presently underway. Results are expected from the TMX upgrade by the close of 1981 and from axisymmetric tandem mirror experiments at the end of 1983. Plans for Phaedrus upgrades are developing for the same period.

12807 (UCID—18525) **Drift microwave plasma heating.** Ensley, D.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Oct 1978. Contract W-7405-ENG-48. 17p. Dep. NTIS, PC A02/MF A01.

A self-consistent plasma simulation code has been used to simulate a hot (5 keV), overdense ($\sim 10^4$), microwave-corona interaction for a hydrogen plasma.

PLASMA DIAGNOSTICS

12808 (N—79-20864) **Ion beam probing of electrostatic fields.** Persson, H. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Feb 1979. 66p. NTIS, PC A04/MF A01.

The determination of a cylindrically symmetric, time-independent electrostatic potential V in a magnetic field B with the same symmetry by measurements of the deflection of a primary beam of ions is analyzed and substantiated by examples. Special attention is given to the requirements on canonical angular momentum and total energy set by an arbitrary, nonmonotone V, to scaling laws obtained by normalization, and to the analogy with ionospheric sounding. The inversion procedure with the Abel analysis of an equivalent problem with a one-dimensional fictitious potential is used in a numerical experiment with application to the NASA Lewis Modified Penning Discharge. The determination of V from a study of secondary beams of ions with increased charge produced by hot plasma electrons is also analyzed, both from a general point of view and with application to the NASA Lewis SUMMA experiment. Simple formulas and geometrical constructions are given for the minimum energy necessary to reach the axis, the whole plasma, and any point in the magnetic field. The common, simplifying assumption that V is a small perturbation is critically and constructively analyzed; an iteration scheme for successively correcting the orbits and points of ionization for the electrostatic potential is suggested.

PLASMA KINETICS - GENERAL

REFER ALSO TO CITATION(S) 12874

12809 (N—79-20868) **Analysis for extraction and bunching of ion beam from spherical reflex triode.** Kawata, S.; Abe, T.; Kasuya, K.; Niu, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1978. 20p. NTIS, PC A02/MF A01.

An analysis was developed for the intense ion beam which is extracted from a spherical reflex triode. The basic equations used are the Poisson equation for the electric potential and the conservation equations of energies for the ion and electron velocities. According to the asymptotic solution, the extracted ion-beam-current density is proportional to the 3/2 power of the voltage imposed on the triode. This dependence of the current density on the voltage is improved to the power of 1.6 by the numerical analysis. A special time-dependence of the ion-beam power at the target surface is required for an optimal implosion of the target. Using the bunching theory for the ion beam, a numerical derivation of an optimal time-dependence of the voltage imposed on the triode is presented. Asymptotic forms are also obtained analytically for the voltage.

12810 (PPPL—1625) **Dissociative excitation as the source of neutral atoms in hydrogen discharges.** McNeill, D.H. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jan 1980. Contract EY-76-C-02-3073. 20p. Dep. NTIS, PC A02/MF A01.

Electron impact dissociative excitation of H_2 molecules is identified as the origin of the narrow width and structure of Balmer lines observed in various low density hydrogen discharges. On the basis of this data and estimates of the rates of competing processes in plasmas, dissociative excitation, together with other molecular reactions, is proposed as the source of neutral atoms and protons in these discharges.

PLASMA KINETICS - EXPERIMENTAL

12811 (PPPL—1586) **Transient getter scheme for the Tokamak Fusion Test Reactor.** Cecchi, J.L.; Cohen, S.A.; Sredniawski, J.J. (Princeton Univ., NJ (USA). Plasma Physics Lab.; Grumman Aerospace Corp., Bethpage, NY (USA)). Jan 1980. Contract EY-76-C-02-3073. 19p. Dep. NTIS, PC A02/MF A01.

The ability of the Tokamak Fusion Test Reactor (TFTR) to attain the largest fusion power gain depends critically on minimizing plasma contamination and controlling the densities of the reacting deuterium and tritium. Experiments on a number of tokamaks have demonstrated that gettering over an appreciable surface area (≧ 10%) of the vacuum vessel greatly facilitates both of these objectives. One particular problem in implementing a surface pumping system in TFTR, however, is a restriction on the maximum allowable tritium content of the getter. This restriction could require regeneration of the absorbed tritium after as few as 50 machine pulses. We have developed a scheme utilizing SAES Zr/Al getter modules which obviates the need for such frequent interruptions of machine operation by taking advantage of the pulsed operation of TFTR. With the Zr/Al getter at temperatures between 500°C to 600°C it is possible to achieve a quasi-steady state in the tritium loading where the quantity of tritium desorbed between pulses is equal to the quantity which is absorbed during a pulse. Since frequent thermal cycling is not required, this scheme also reduces the possibility of Zr/Al getter material fatigue.

PLASMA KINETICS - THEORETICAL

12812 (ANL/FPP/TM—124) **Kinetic solution of the sheath region in a fusion reactor.** Brooks, J.N. (Argonne National Lab., IL (USA)). Dec 1979. Contract W-31-109-ENG-38. 22p. Dep. NTIS, PC A02/MF A01.

The sheath region in a fusion reactor is studied with a one-dimensional kinetic code. The sheath potential, heat transmission, and sputtering of the boundary are all quite sensitive to electron re-emission. The expected heat and particle fluxes in future fusion reactors leads to a prediction of keV-edge temperatures.

12813 (N—79-16669) **Population inversion in recombining hydrogen plasma.** Furukane, U.; Yokota, T.; Oda, T. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1978. 26p. NTIS, PC A03/MF A01.

The collisional-radiative model is applied to a recombining hydrogen plasma in order to investigate the plasma condition in which the population inversion between the energy levels of hydrogen can be generated. The population inversion is expected in a plasma where the three body recombination has a large contribution to the recombining processes and the effective recombination rate is beyond a certain value for a given electron density and temperature. Calculated results are presented in figures and tables.

12814 (N—79-16670) **Complementary variational principles on electrical conductivities of a plasma in a uniform magnetic field.** Kaneko, S. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1978. 21p. NTIS, PC A03/MF A01.

Several functionals, whose Euler-Lagrange equations are the kinetic equations for the velocity distribution functions, are derived. The extremal values of these functionals are proved to be proportional to the ohm conductivity or to the Hall conductivity. The complementary variational principles, which give both lower and upper bounds for both conductivities, are derived by use of these functionals. These principles are applied to a plasma composed of electrons and singly charged positive ions.

12815 (N—79-19867) **Ion confinement and transport in a toroidal plasma with externally imposed radial electric fields.** Roth, J.R.; Krawczonek, W.M.; Powers, E.J.; Kim, Y.C.; Hong, H.Y. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Mar 1979. 86p. NTIS PC A05/MF A01.

Strong electric fields were imposed along the minor radius of the toroidal plasma by biasing it with electrodes maintained at kilovolt potentials. Coherent, low-frequency disturbances characteristic of various magnetohydrodynamic instabilities were absent in the high-density, well-confined regime. High, direct-current radial electric fields with magnitudes up to 135 volts per centimeter penetrated inward to at least one-half the plasma radius. When the electric field pointed radially toward, the ion transport was inward against a strong local density gradient; and the plasma density and confinement time were significantly enhanced. The radial transport along the electric field appeared to be consistent with fluctuation-induced transport. With negative electrode polarity the particle confinement was consistent with a balance of two processes: a radial infusion of ions, in those sectors of the plasma not containing electrodes, that resulted from the radially inward fields; and ion losses to the electrodes, each of the which acted as a sink and drew ions out of the plasma. A simple model of particle confinement was proposed in which the particle confinement time is proportional to the plasma volume. The scaling predicted by this model was consistent with experimental measurements.

12816 (N—79-19872) **The influence of diffusion and reabsorption of radiation on the particle and energy balance of an infinitely long quasi-cylindrical discharge in hydrogen gas.** Geodheer, W.J. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Inst. voor Plasma-Fysica). Sep 1978. 54p. NTIS PC A04/MF A01.

A model, which accounts for the diffusion of electrons, ions and neutral atoms in the ground state and for the reabsorption of Lyman-alpha and Lyman-beta radiation in an infinitely long quasi-cylindrical discharge in hydrogen gas was constructed. The transport theory for a toroidal plasma of high collisionality was used. The assumptions that form the basis are discussed.

12817 (ORNL/TM—7107) **General principles of magnetic fusion confinement.** Hogan, J.T. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 40p. Dep. NTIS, PC A03/MF A01.

A few of the areas are described in which there is close interaction between atomic/molecular (A and M) and magnetic fusion physics. The comparisons between predictions of neoclassical transport theory and experiment depend on knowledge of ionization and recombination rate coefficients. Modeling of divertor/scrapeoff plasmas requires better low energy charge exchange cross sections for H + A/sup n+/ collisions. The range of validity of neutral beam trapping cross sections must be broadened, both to encompass the energies typical of present injection experiments and to deal with the problem of prompt trapping of highly excited beam atoms at high energy. Plasma fueling models present certain anomalies that could be resolved by calculation and measurement of low energy (<1 keV) charge exchange cross sections.

12818 (PPPL—1572) **Current penetration in the PLT tokamak.** Hawryluk, R.J.; Bretz, N.; Dimock, D.; Hinnov, E.; Johnson, D.; Monticello, D.; McCune, D.; Suckewer, S. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jan 1980. Contract EY-76-C-02-3073. 35p. Dep. NTIS, PC A03/MF A01.

Current penetration in the PLT tokamak is modeled by a one dimensional magnetic field diffusion code assuming neoclassical resistivity. The code uses the measured temperature and density profiles as well as current and voltage measurements to evaluate Z/sub eff/. Under certain conditions, the resulting calculations of Z/sub eff/ during the startup phase have been considerably larger than the Z/sub eff/ determined spectroscopically indicating the presence of an enhanced current penetration mechanism. Furthermore, these calculations indicate that the gross energy confinement time is substantially less during the startup phase than in the quasi-steady state.

12819 (SAI—023-79-1056LJ) **ANTIC: a code for calculation of neutral transport in cylindrical plasmas.** Tamor, S. (Science Applications, Inc., La Jolla, CA (USA). Lab. for Applied Plasma Studies). Dec 1979. Contract EY-76-C-03-1018. 40p. (LAPS—50). Dep. NTIS, PC A03/MF A01.

A scheme for computing the steady state transport of neutral atoms in cylindrical plasmas is described. The physical model used represents atoms emerging from charge exchange collisions by an isotropic source of neutrals with energy equal to 3/2 times the local ion temperature. The processes of charge exchange and impact ionization by electrons and ions are included. The transport can be described by an integral equation for the charge exchange collision density, and this equation approximated by a set of algebraic equations for the zone average collision densities. A derivation of the appropriate kernel and a technique for computing it are presented. Comparison of computed results with predictions of other, more exact, codes exhibit quite satisfactory agreement for temperatures as high as 10 keV.

12820 (UCID—18495) **Determination of the radius of a self-pinched beam from its energy integral.** Lee, E.P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Jan 1980. Contract W-7405-ENG-48. 15p. Dep. NTIS, PC A02/MF A01.

The total transverse energy (kinetic plus potential) of a self-pinched beam may be used to predict the final equilibrium radius when the beam is mismatched at injection. The dependence of potential energy on the current profile shape is characterized by a dimensionless parameter C(z), variations of which are correlated with the change of emittance.

PLASMA INSTABILITIES

REFER ALSO TO CITATION(S) 12722

12821 (DOE/ET—53074) **Fusion theory and computations.** Bers, A.; Coppi, B.; Davidson, R.; Dupree, T.; Freidberg, J.; Molvig, K.; McCune, J. (Massachusetts Inst. of Tech., Cambridge (USA).

Plasma Fusion Center). 1979. Contract AS02-78ET53074. 61p. Dep. NTIS, PC A04/MF A01.

It is proposed to carry out theoretical studies of the equilibrium, stability, transport and heating properties of high-temperature fusion plasmas. Continued emphasis will be placed on the effective interface of fusion theory and computations with the local Alcator, Versator, Constance and Torex experimental programs. The proposed research includes but will not be limited to the following types of studies: (a) investigation of RF heating of toroidal plasmas, (b) investigation of the MHD equilibrium and stability properties of tokamak plasmas, (c) develop the basic understanding of a wide variety of non-linear and turbulent phenomena, including stochastic magnetic fields, clumps and nonlinear saturation of linear instabilities, (d) investigate the effects of ambipolar fields on transport and stability properties of toroidal plasmas. Investigate high-beat stability properties of tandem-mirror systems, and (e) investigation of the MHD equilibrium and stability properties of Torsatron/Stellarator configurations.

12822 (N—79-20865) **Formation of convective cells by modulational instability of drift alfven waves.** Weiland, J.; Sanuki, H. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jan 1979. 16p. NTIS, PC A02/MF A01.

A model equation describing drift Alfven wave with E x B nonlinearity is derived. For a special ordering a nonlinear Schrodinger equation is derived, which governs modulational instability of the drift Alfven wave. Translational invariance is assumed along the magnetic field. The relation between the characteristic scale lengths parallel and perpendicular to the drift flow for the onset of cell formation is found to depend on if the wave propagates parallel or antiparallel to the drift flow and on the sign of the wave energy. The influence of perpendicular ion viscosity is discussed.

12823 (N—79-20867) **Numerical analysis of current-driven collisional drift and Alfven instabilities in a sheared magnetic field.** Nishikawa, K.I. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Dec 1978. 11p. NTIS, PC A02/MF A01.

Collisional drift eigenmode, coupled to shear Alfven mode, is studied numerically in a current-carrying slab with finite magnetic shear. It is shown that, due to finite-beta effects, in the presence of current, a drift mode becomes unstable.

12824 (N—79-20869) **Numerical investigation of current driven dissipative drift wave turbulence including finite beta and quasilinear effects in a tokamak plasma.** Weiland, J. (Nagoya Univ. (Japan). Inst. of Plasma Physics). 1978. 32p. NTIS, PC A03/MF A01.

Excitation of dissipative drift wave turbulence with waves propagating perpendicular to the density gradient is studied numerically, taking an average over the gradient coordinate. Both situations where the plasma current is the main source of instability and situations more close to an ordinary dissipative drift wave excitation were investigated in the presence of finite beta effects and ion viscosity. The main saturation mechanism was quasilinear modification of the background density. In addition to the usual current induced growth, the current is also found to decrease the finite beta stabilization.

12825 (PPPL—1622) **Ballooning-mode theory of trapped-electron instabilities in tokamaks.** Cheng, C.Z.; Chen, L. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Dec 1979. Contract EY-76-C-02-3073. 19p. Dep. NTIS, PC A02/MF A01.

Employing the ballooning-mode formalism, the two-dimensional eigenmode equation for trapped-electron instabilities in tokamaks is reduced to a one-dimensional integro-differential equation along the magnetic field lines; which is then analyzed both analytically and numerically. Dominant toroidal coupling effects are due to ion magnetic drifts which create quasi-bounded states. The trapped-electron response can be treated as perturbation and is found to destablize the quasi-bounded states.

PLASMA WAVE PHENOMENA

12826 (N—79-20866) **The development of soliton physics: an analysis based on information retrieval.** Ichikawa, Y.H.; Ohe, T.; Kanada, Y. (Nagoya Univ. (Japan). Inst. of Plasma Physics). 1979. 23p. NTIS, PC A02/MF A01.

Information retrieval is used from available data bases such as INSPEC tapes in an attempt to quantify and demonstrate trends in the recent development of Soliton physics research. The date shows that Soliton physics research may be classified into three stages according to the annual numbers of published scientific papers (N): Stage 1, N - 1 Gestation (up to 1965); Stage 2, N - 10 Introduction (1966 - 1971); Stage 3, N - 100 Growth (1971 - present).

12827 (SAI—254-79-933-LJ) **Mode coupling in a toroidal, sharp-boundary plasma. I. Weak-coupling limit.** D'Ippolito, D.A.; Goedbloed, J.P. (Science Applications, Inc., Boulder, CO (USA). Plasma Research Inst.; FOM-Instituut voor Plasmafysica, Jutphaas (Netherlands)). Dec 1979. Contract EY-76-C-03-1018. 37p. Dep. NTIS, PC A03/MF A01.

The phenomenon of mode coupling in the discrete Alfven wave spectrum of ideal magnetohydrodynamics is studied using a simplified plasma model. It is shown that mode coupling occurs when a periodic modulation of the equilibrium magnetic field strength and curvature is introduced, either by toroidicity or by noncircularity of the cross section. The existence of gaps in the frequency spectrum and the spatial localization of the eigenfunction as a result of mode coupling is analogous to the behavior of valence electrons in a one-dimensional crystal lattice.

FUSION POWER PLANT TECHNOLOGY

12828 (CONF-791013—10) **Review of the ISX-B experimental program.** Saltmarsh, M.J. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 27p. Dep. NTIS, PC A03/MF A01.

From 26. national vacuum symposium; New York, NY, USA (2 Oct 1979).

The ISX-B tokamak is a modestly sized device that is designed to explore questions closely related to the design of future tokamak devices, such as the Engineering Test Facility (ETF). The major program emphasis is on high-β plasma operation using neutral beams to heat plasmas with noncircular cross sections. In addition, substantial efforts are under way or planned in the areas of plasma-wall interactions, coated limiter studies, electron-cyclotron heating, ripple injection, impurity flow reversal, pellet injection, and the application of a bundle divertor. The current status and future plans for these programs are reviewed.

BLANKET ENGINEERING

REFER ALSO TO CITATION(S) 11901

12829 (BNL—26878) **NOEL-A no-leak fusion blanket concept.** Yu, W.S.; Powell, J.R.; Fillo, J.; Horn, F.; Makowitz, H. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 8p. (CONF-791102—87). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

Thermal analysis and tests of a non-leak fusion blanket concept (NOEL-No External Leak) are presented. The NOEL blanket module operates with a material A that is present in both its solid and liquid phases. The solid phase zone of material A is maintained as a thick lining on the inside of blanket module shells (which are made of stainless steel, aluminum or any other structural metal and serve as the first wall) by cooling tubes embedded in the solid zone. These metal tubes carry a liquid or gas coolant B at a temperature below the melting point of A. Most of the 14 MeV neutron energy is deposited as heat in the module interior, and the temperature increase from the shell to the interior due to heat flow is sufficient to keep the interior liquid. Pressure on the liquid A interior is maintained at a higher level than the pressure on B, so that B can not leak out if failures occur in the coolant tubes embedded in the frozen layer.

12830 (BNL—26975) **Thermal hydraulics of fusion-synfuel blankets.** Horn, F.L.; Fillo, J.A.; Powell, J.R. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 6p. (CONF-791102—84). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

Thermal hydraulic calculations are performed for two blanket designs for synfuel applications. Tradeoffs in temperature and pressure drop for the blanket design, i.e., log versus cylindrical shaped modules as well as flow across packed beds or along rods, are assessed. In either design the outer cooled stainless steel shell is maintained at $\sim$ 300°C while the high temperature steam-cooled region may reach 1400 to 1500°C. Steam flow rates and pressure drops are found to be reasonable, as are the helium flow rates and pressure drops for the electric power production modules.

12831 (PPPL-EPRI—8) **Engineering test station for TFTR blanket module experiments.** Jassby, D.L.; Leinoff, S. (Princeton Univ., NJ (USA). Plasma Physics Lab.; Grumman Aerospace Corp., Bethpage, NY (USA)). Dec 1979. Contract EY-76-C-02-3073. 9p. (CONF-791102—91). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

A conceptual design has been carried out for an Engineering Test Station (ETS) which will provide structural support and utilities/instrumentation services for blanket modules positioned adjacent to the vacuum vessel of the TFTR (Tokamak Fusion Test Reactor). The ETS is supported independently from the Test Cell floor. The ETS module support platform is constructed of fiberglass to elimi-

nate electromagnetic interaction with the pulsed tokamak fields. The ETS can hold blanket modules with dimensions up to 78 cm in width, 85 cm in height, and 105 cm in depth, and with a weight up to 4000 kg. Interfaces for all utility and instrumentation requirements are made via a shield plug in the TFTR igloo shielding. The modules are readily installed or removed by means of TFTR remote handling equipment.

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 12806

12832 (COO—5069-28) **Current density profile measurements in the Proto-Cleo Torsatron.** Schaeffer, R.C.; Shohet, J.L. (Wisconsin Univ., Madison (USA). Engineering Experiment Station). Oct 1979. Contract ET-78-S-02-5069. 19p. Dep. NTIS, PC A02/MF A01.

Current density profile measurements were obtained in the Proto-Cleo Torsatron (R = 40 cm, a = 5 cm, l = 3, B/sub T/ = 3 kG, anti n ~ 10^{11} cm^{-3}, T/sub e/ ~ 20 eV) by using a small, back-to-back flat double probe. Three different operating circuits used with this probe are presented, along with experimental results, all showing good agreement. Current is seen to flow only within the separatrix, in channels which follow the magnetic surfaces as they move radially inward with time due to changing vertical magnetic flux.

12833 (COO—5069-29) **Engineering design of superconducting magnets for a torsatron experiment.** Van Sciver, S.W.; Eyssa, Y.M.; Hilal, M.A.; Miller, C.; Shohet, J.L. (Wisconsin Univ., Madison (USA)). 1979. Contract ET-78-S-02-5069. 3p. (CONF-791102—93). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

The design of superconducting magnets for a torsatron plasma confinement experiment are presented. A torsatron is a variation of a stellarator which requires half the helical windings and no toroidal field coil. Both the toroidal and poloidal fields are produced by a single set of helical winding. Due to the particular distribution of magnetic forces in the helical windings, the design of a torsatron configuration requires special consideration. In this paper, we present the force distribution on the helical coils. For the special case of uniformly distributed winding, magnetic forces and energy are calculated directly from formula for the inductance of toroids and dipoles. Significant reduction in the standard requirement can be achieved if the winding angle can be set at a particular value.

12834 (PPPL—1620) **Steady-state resistive toroidal-field coils for tokamak reactors.** Kalnavarns, J.; Jassby, D.L. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Dec 1979. Contract EY-76-C-02-3073. 10p. (CONF-791102—88). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

If spatially-averaged values of the beta ratio can reach 5 to 10% in tokamaks, as now seems likely, resistive toroidal-field coils may be advantageous for use in reactors intended for fusion-neutron applications. The present investigation has parameterized the design of steady-state water-cooled copper coils of rectangular cross section in order to maximize figures of merit such as the ratio of fusion neutron wall loading to coil power dissipation. Four design variations distinguished by different ohmic-heating coil configurations have been examined. For a wall loading of 0.5 MW/m_2, minimum TF-coil lifetime costs (including capital and electricity costs) are found to occur with coil masses in the range 2400 to 4400 tons, giving 200 to 250 MW of resistive dissipation, which is comparable with the total power drain of the other reactor subsystems.

12835 (UCRL—15148) **Structural analysis interpretation task for the magnet system for Mirror Fusion Test Facility (MFTF).** Baldi, R.W. (General Dynamics/Convair, San Diego, CA (USA)). Nov 1979. Contract W-7405-ENG-48. 42p. Dep. NTIS, PC A03/MF A01.

The primary objective of this study was to develop recommendations to improve and substantiate the structural integrity of the highly stresses small radius region of the MFTF magnet. The specific approach is outlined: (1) Extract detail stress/strain data from General Dynamics Convair Finite-Element Refinement Analysis. (2) Diagram local plate stress distribution and its relationship to the adjacent weldment. (3) Update the parametric fracture mechanics analysis using most recent MFTF related data developed by National Bureau of Standards. (4) Review sequence and assembly as modified by Chicago Bridge and Iron for adaptability to refinements. (5) Investigate the need for fillet radii weldments to reduce stress concentrations at critical corners. (6) Review quality assurance plan for adequacy to insure structural quality in the small radius region. (7) Review instrumentation plan for adequacy of structural diagnostics in small radius region. (8) Participate in planning a small-scale fatigue test program of a typical MFTF weldment. (MOW)

12836 (UCRL—15156) **Final report covering work done under LLL P.O. No. 4165009.** Spencer, C. (Airco, Inc., Murray Hill, NJ (USA). Central Research Labs.). 21 Sep 1979. Contract W-7405-ENG-48. 22p. (SU—79-107). Dep. NTIS, PC A02/MF A01.

The High Field Test Facility (HFTF) to be built at Lawrence Livermore Laboratories (LLL) consists of a magnet which will be wound with Nb_3Sn superconductor. Embossed and electroplated copper strip will be soldered to the two broad sides of a rectangular Nb_3Sn superconductor 5.4 mm x 11.0 mm x approximately 100 m long. It is the purpose of this project to upgrade existing facilities to emboss the copper stabilizer strip, electroplate the strip with 50 Pb-50 Sn solder, and to solder two such strips to the superconductor. This program has been approached in seven separate tasks which are described in this report.

12837 (UCRL—83792) **Stellarmak a hybrid stellarator: Spheromak.** Hartman, C.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Jan 1980. Contract W-7405-ENG-48. 6p. (CONF-791225—5). Dep. NTIS, PC A02/MF A01.

From Symposium on compact toruses and energetic particle injection; Princeton, NJ, USA (11 Dec 1979).

This paper discusses hybridization of modified Stellarator-like transform windings (T-windings) with a Spheromak or Field-Reversed-Mirror configuration. This configuration, Stellarmak, retains the important topological advantage of the Spheromak or FRM of having no plasma linking conductors or blankets. The T-windings provide rotational transformation in toroidal angle of the outer poloidal field lines, in effect creating a reversed B/sub Toroidal/ Spheromak or adding average B/sub T/ to the FRM producing higher shear, increased limiting β, and possibly greater stability to kinks and tilt. The presence of field ripple in the toroidal direction may be sufficient to inhibit cancellation of directed ion current by electron drag to allow steady state operation with the toroidal as well as poloidal current maintained by neutral beams.

12838 **Vapor formation and heat transfer in liquid helium cooling channels under transient and steady state conditions.** Hilal, M.A.; Dawson, J.W.; Gonczy, J.D.; Turner, L.R.; Wang, S.T. (Argonne Natl Lab, Ill). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 59-62(Jan 1979).

The recovery of a normal zone produced in a superconducting magnet following a mechanical disturbance depends on the heat transfer rate to the liquid helium cooling channels. One of the factors which affects the heat transfer to the channel is the amount of vapor accumulated in the channel during and following a disturbance. Work was undertaken to determine the void fraction in a liquid helium channel and to study the effect of the amount of vapor in the channel on the heat transfer characteristics. Heat pulses of 30 to 300 ms are introduced into the simulated conductor, and observations are made of the resulting temperature response and of the vapor fraction in the channel. The vapor fraction is determined by a capacitance bridge which responds to the small difference in dielectric constant between liquid and vapor helium. Steady-state measurements of temperature and vapor fraction are reported. 8 refs.

12839 **Superconducting ohmic-heating coil simulation.** Thullen, P.; Lindsay, J.D.G.; Weldon, D.M.; Vogel, H.F. (Los Alamos Sci Lab, NM). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 538-541(Jan 1979).

Superconducting coils have been proposed for use as ohmic-heating coils in most tokamak and reverse field pinch fusion reactors. Lack of knowledge about the behavior of superconducting coils performing the required bipolar flux swings may delay their application in future fusion reactors. The Los Alamos Scientific Laboratory has undertaken a study to show how such coils can be constructed. The work is based on experience gained during the fast discharge (1 ms) magnetic energy transfer and storage (METS) program. Experiments in which a typical ohmic-heating current waveform is simulated have been undertaken using the 300-kj, 10-ka METS superconducting coil, a 500-kw, 250-v, 2-ka dc motor generator set used as a capacitor, and a rectifier power supply. The coil has undergone full bipolar flux swings to greater than rated current (;plus or minus;12-ka, 430 kj) and remained superconducting. The commutator dc machine has functioned successfully as a capacitor up to 12 ka. The test circuits and the components are described. Terminal characteristics are presented. Coil energy losses are presented as a function of the terminal current. These tests support the viability of bipolar pulsed superconducting coils for use in tokamaks and other fusion concepts. 5 refs.

12840 **Performance tests of a 1.5 MJ pulsed superconducting coil and its cryostat.** Kim, S.H.; Wang, S.T.; Praeg, W.F.; Kreiger, C.I.; Lieberg, M. (Argonne Natl Lab, Ill). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 840-842(Jan 1979).

To demonstrate cryostability of large pulsed superconducting ohmic heating (OH) coils for Tokamak power reactors, a 1.5 MJ coil was developed. The coil was first charged up to 11.2 ka dc, which is the critical current of short sample cables at 4.5 T. Above the critical current, an unbalance voltage of the coil increased smoothly indicating stable current sharing between the superconducting filaments and the copper stabilizer. The coil was then pulsed with a 7 Mw

power supply. The highest ramping rate was 11 T/s. AC losses, mainly eddy current losses in the copper stabilizer, were proportional to B;sup 2; with about 2.5 kw at 9 T/s. After 3000 pulses, no degradation of the coil performance has been observed. A nonmetallic cryostat was developed for testing the coil to avoid eddy currents in the cryostat. 2 refs.

POWER SUPPLIES, ENERGY STORAGE

12841 (GA-A—15658) **1.5 megawatt dc chopper power supplies for plasma shape control on Doublet III.** Rock, P.J.; Wesley, J.C. (General Atomic Co., San Diego, CA (USA)). Nov 1979. Contract AT03-76ET51011. 8p. (CONF-791102—75). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

The Doublet III device is designed to study noncircular plasmas, including doublet and dee-shaped cross-sections. The plasma shape is determined by a system of 24 field-shaping coils which surround the vacuum vessel. Control of the magnetic flux linking these coils allows the plasma shape to be varied and controlled. This paper describes the high-speed dc chopper which is a major component of the field-shaping coil power system. The high-speed dc choppers, with a frequency response of up to 5 kHz and a switching power capability of 1.5 megawatts are used for fine tuning and feedback control of the plasma position and shape. The design and operation of two 1.5 megawatt, 3 kHz choppers used on closed loop plasma control experiments will be presented.

12842 (GA-A—15660) **Function and operation of the Doublet III E-coil vacuum breaker system.** Callis, R.W.; Jackson, G.; DeGrassie, J.; Peterson, P.; LeVine, F. (General Atomic Co., San Diego, CA (USA)). Nov 1979. Contract AT03-76ET51011. 7p. (CONF-791102—76). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

The ohmic heating system for the Doublet III fusion research device at General Atomic is required to provide the voltage for the initial breakdown phase (there is no preionization) along with the energy to drive the plasma current to a value of 2.5 MA or greater. This requires a peak one turn voltage of 250 volts (16 kV across coil terminals) and a magnetic flux swing of 5 volt-seconds (peak coil current of 110 kA). This voltage and flux swing is accomplished by reverse biasing the ohmic heating coil (E-coil) where, upon reaching a value of 110 ka the coil current is interrupted and commutated into a RC network producing 16 kV across the coil. The interruption of the E-coil current is accomplished by the use of an array of vacuum circuit breakers (VCB's) and a counter plus network. A description is given of the ohmic heating circuit and the performance of the vacuum circuit breaker array and its counter pulse system. (MOW)

HEATING AND FUELING SYSTEMS

12843 (LBL—9406) **Protection and fault detection for Lawrence Berkeley Laboratory neutral beam sources.** Hopkins, D.B.; Baker, W.R.; Berkner, K.H.; Ehlers, K.W.; Honey, V.J.; Lietzke, A.F.; Milnes, K.A.; Owren, H.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 8p. (CONF-791102—90). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

Testing of TFTR neutral beam (NB) sources has begun at the LBL Neutral Beam System Test Facility (NBSTF). Operation at 120 kV, 65 A, 0.5 sec should be achieved soon. Because NB sources spark down frequently during conditioning, the main accelerating (accel) power supply must be interrupted within a few microseconds to avoid degrading the voltage holding capability, or even the damaging, of the NB source. A variety of improper magnitudes and/or ratios of voltages, currents, and times can occur and must be recognized as fault conditions in order to initiate a prompt interruption of the accel power supply. This paper discusses in detail the key signals which must be monitored and the manner in which they are processed in fault detector circuitry for safe operation of LBL NB sources. The paper also reviews the more standard interlocks and protective features recommended for these sources.

12844 (ORNL/SUB—21453/1) **EBT-P 110 GHZ development program. Quarterly report No. 1, September 1979.** Shively, J.; Conner, C.; Friedlander, F.; Galli, E.; Jory, H.; Stone, D.; Symons, R.; Wendell, G. (Varian Associates, Inc., Palo Alto, CA (USA)). 1979. Contract W-7405-ENG-26. 41p. Dep. NTIS, PC A03/MF A01.

The objective of this program is to develop a microwave amplifier or oscillator capable of producing 200 kW CW power output at 110 GHz. The use of cyclotron resonance interaction is being pursued. The early design phases of this three and one half year program are discussed.

12845 (ORNL/TM—7124) **Deuterium and tritium fuelding in an ETF/INTOR plasma with divertor.** Houlberg, W.A.; Howe, H.C.; Attenberger, S.E. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 34p. Dep. NTIS, PC A03/MF A01.

Fueling by pellets and neutral gas in the presence of a divertor is examined with a one-dimensional multispecies transport code. Deuterium, tritium, and alpha particles are treated as independent thermal species. With an efficiently operating divertor, it becomes impossible to maintain high plasma density (anti n $\sim 10^{14}$ cm^{-3}) with neutral gas fueling alone because of the high probability of the gas being ionized in the scrapeoff layer. Pellet fueling significantly reduces the particle load on the divertor and, with feedback control, can maintain the plasma density at the desired level. A low level of deuterium gas fueling can then be used to maintain the density of the scrapeoff layer and increase shielding against sputtered impurities. Even with an effective shielding divertor, the energy and particle fluxes to the first wall from both charged and neutral particles may be significant. The fluctuations at the plasma edge and in the scrapeoff layer introduced by the pellets cause the particle and energy fluxes to the divertor and first wall to fluctuate. This makes simulation more difficult but may be used to experimentally determine radial and parallel transport properties in the scrapeoff layer. Recommendations for further study are made.

TRITIUM PROCESSING, ENVIRONMENT AND SAFETY

12846 (ANL/FPP/TM—122) **Theory and use of the radioactivity code RACC.** Jung, J. (Argonne National Lab., IL (USA)). May 1979. Contract W-31-109-ENG-38. 179p. Dep. NTIS, PC A09/MF A01.

This document serves as a user's manual for a FORTRAN-IV program RACC. RACC computes radioactivity and radioactivity-related parameters such as decay heat, decay gamma spectrum and biological hazard potential (BHP), primarily for fusion reactor systems. The computational algorithm in RACC is based on Gear's stiffly stable method. The RACC code features a versatile geometric capability including slab, sphere, cylinder, and torus in multidimensions. RACC is capable of interfacing with most of the standard multigroup, multidimensional neutron/photon transport codes currently available for fusion system application. In order to facilitate user's problem setup, all input arrays are read using the FIDO system.

12847 (LA-UR—79-3277) **Tritium control at the Tritium Systems Test Assembly.** Jalbert, R.A. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 5p. (CONF-800304—1). Dep. NTIS, PC A02/MF A01.

From 5. international congress of the International Radiation Protection Association; Jerusalem, Israel (8 Mar 1980).

The Tritium Systems Test Assembly (TSTA) is a computer-controlled facility designed to mock up full-scale the deuterium-tritium fuel cycle of next-generation tokamak fusion test reactors. Such reactors will use or build on the experience and technologies of the TSTA and other engineering facilities. The TSTA is presently under construction at the Los Alamos Scientific Laboratory and will be fully operational in 1982.

INERTIAL CONFINEMENT TECHNOLOGY

REFER ALSO TO CITATION(S) 12299, 12349

12848 (AD-A—068470) **NRL inertial confinement fusion theory program 1978 annual report, October 1977 - September 1978. Interim report.** (Naval Research Lab., Washington, DC (USA)). 26 Feb 1979. 110p. NTIS, PC A06/MF A01.

This annual report of the NRL Inertial Confinement Fusion Theory Program covers research performed in each of the following five current program areas: (A) Transport of Charged Particle Beams; (B) Laser and Particle Beam Absorption; (C) Fluid Dynamics and Ablative Acceleration; (D) Development of Computational Techniques; and (E) Rayleigh-Taylor Stabilization Techniques.

12849 (DOE/NV/40023—T1) **Phase conjugation for laser fusion. Final report, 15 June 1979-14 October 1979.** Steel, D.G.; Lind, R.C. (Hughes Research Labs., Malibu, CA (USA)). Nov 1979. Contract ED-78-C-08-1563. 47p. Dep. NTIS, PC A03/MF A01.

Separate abstracts were prepared for each of the four included appendices. (MOW)

12850 (DOE/NV/40023—T1, pp 7-33) **Degenerate four-wave mixing in a resonant homogeneously broadened system.** Lind, R.C.; Steel, D.G. Nov 1979.

In Phase conjugation for laser fusion. Final report, 15 June 1979-14 October 1979.

Detailed measurements have been made of degenerate four-wave mixing (DFWM) in a resonant homogeneously broadened gas. The measurements were performed in SF_6 using a CO_2 laser operated on the 10.4-μm branch. The experimental results were compared

to a two-level theory for a resonant saturable absorber developed by Abrams and Lind. The measured value of 7% reflectivity on the P(20) line was in excellent agreement with Abrams and Lind when corrected for thermal motion. A peak reflectivity of 38% was observed for off-resonant operation on the P(8) line. In addition to the usual two-level nonlinear response, discussion and measurement of the coherent three-level nonlinearity is also presented. A two-photon contribution in SF_6 using the P(16) line of CO_2 equals the one-photon response. Initial observations of coherent propagation effects are also presented.

12851 (DOE/NV/40023—T1, pp 35-37) **Phase conjugation at 10.6 μm by resonantly enhanced degenerate four-wave mixing.** Lind, R.C.; Steel, D.G.; Klein, M.B.; Abrams, R.L.; Giuliano, C.R.; Jain, R.K. Nov 1979.

In Phase conjugation for laser fusion. Final report, 15 June 1979-14 October 1979.

A resonantly enhanced phase-conjugate 10.6-μm signal has been generated in the saturable absorber SF_6. Direct evidence of aberration correction is shown through the use of far-field photographs taken with a pyroelectric vidicon camera. Reflection coefficients of 7% have been achieved in a few Torr of SF_6 for a 2-cm interaction length.

12852 (DOE/NV/40023—T1, pp 39-42) **Two-photon coherent-transient measurement of the nonradiative collisionless dephasing rate in SF_6 via Doppler-free degenerate four-wave mixing.** Steel, D.G.; Lam, J.F. Nov 1979.

In Phase conjugation for laser fusion. Final report, 15 June 1979-14 October 1979.

This letter reports, for the first time, an experimental measurement of the collision-less dephasing time of the $\nu_3 = 2$ level in SF_6 using Doppler-free two-photon degenerate four-wave mixing. The measurement is performed in the time domain by use of a short-pulse CO_2 laser to establish a molecular two-photon coherent state. The coherent state is then probed as a function of time to yield a dephasing time of 1.8 nsec which is related to intramolecular dephasing rates.

12853 (DOE/NV/40023—T1, pp 43-46) **Polarization-rotation and thermal-motion studies via resonant degenerate four-wave mixing.** Steel, D.G.; Lind, R.C.; Lam, J.F.; Giuliano, C.R. Nov 1979.

In Phase conjugation for laser fusion. Final report, 15 June 1979-14 October 1979.

We report experimental observation of polarization rotation in resonant degenerate four-wave mixing (DFWM) arising from the third-order coupling of the electric fields. This effect allows investigation of molecular motion and it effect on the efficiency of the DFWM. By controlling the pulse width and therefore $\gamma = T_0/\tau$ (where T_0 identical with λ/v th) we show quantitative agreement with a third-order density matrix perturbation calculation. In particular, using a CO_2 laser at 10.6 μm and SF_6 as the nonlinear medium, we show that for $\gamma > 1$ (stationary limit) we see no molecular motion and for γ approx. = 1, we see a significant washout of one third-order polarization.

12854 (LBL—10291) **Heavy Ion Fusion Program. Year-end report, October 1978-September 1979.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1979. Contract W-7405-ENG-48. 31p. Dep. NTIS, PC A03/MF A01.

The more significant activities and results reported for this year are: (1) Commissioning, in January 1979, of a large-area Cs^{+1} ion source of 1.2 amperes at 500 kV. (2) Commissioning, in July 1979, of the first drift-tube of the three drift-tube accelerator. (3) Acceleration, in January 1979, of a high-brightness, 40 milliampere Xe^{+1} beam through a Cockcroft-Walton column to 500 kV and confirmation of satisfactory emittance and charge distribution. (4) Development of a conceptual design for a 500 J induction linac testbed facility to test many of the features needed for the success of an igniter (LBL PUB 5031). (5) Improvements to the systems studies of a Heavy Ion Induction Linac Driver over a wide parameter range with emphasis on cost and efficiency trade-off. (6) Start-up of a (Cs^{+1}, Cs^{+1}) ion-ion cross section measurement program. Initial results of the scattering of Cs^{+1} ions on Xe gas (electronically similar to Cs^{+1}) have shown some surprising results. (7) Expansion of theoretical studies on the behavior of space-charge dominated ion beams.

12855 (SAND—79-1011) **Particle beam fusion. Progress report, April 1978-December 1978.** (Sandia Labs., Albuquerque, NM (USA)). Dec 1979. Contract EY-76-C-04-0789. 156p. Dep. NTIS, PC A08/MF A01.

During this period substantial improvements in the theoretical basis for particle beam fusion as well as the execution of critical experiments were instrumental in further definition of the optimum route to our goals of demonstrating scientific and practical feasibility. The major emphasis in the program continues to be focused primarily on issues of power concentration and energy deposition of intense particle beams in solid targets. This utilization of program resources is directed toward conducting significant target implosion and thermonuclear burn experiments using EBFA-I (1 MJ) in the 1981-1983 time period. This step, using EBFA-I, will then set the stage for net energy gain experiments to follow on EBFA-II (> 2 MJ) after 1985. Current program emphasis and activities differ substantially from those stressed in the laser approaches to inertial confinement fusion. Here the critical issues relate to delivering the needed power densities and energies to appropriate targets and to insure that the coupling of energy is efficient and matches target requirements.

12856 (SAND—79-1629) **Automatic calibration and signal switching system for the particle beam fusion research data acquisition facility.** Boyer, W.B. (Sandia Labs., Albuquerque, NM (USA)). Sep 1979. Contract EY-76-C-04-0789. 103p. Dep. NTIS, PC A06/MF A01.

This report describes both the hardware and software components of an automatic calibration and signal system (Autocal) for the data acquisition system for the Sandia particle beam fusion research accelerators Hydra, Proto I, and Proto II. The Autocal hardware consists of off-the-shelf commercial equipment. The various hardware components, special modifications and overall system configuration are described. Special software has been developed to support the Autocal hardware. Software operation and maintenance are described.

12857 (SAND—79-1927C) **Ion beam energy deposition physics for ICF targets.** Mehlhorn, T.A. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 4p. (CONF-800208—4). Dep. NTIS, PC A02/MF A01.

From Tropical meeting on inertial confinement fusion; San Diego, CA, USA (26 Feb 1980).

The target interaction physics of light ion beams will be described. The phenomenon of range shortening with increasing material temperature will be corroborated, and the concomittant phenomenon of range relengthening due to ion-electron decoupling will be introduced.

12858 (SAND—79-1943C) **Two-frame flash x-radiography system for target implosion studies.** Chang, J.; Fehl, D.L. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 4p. (CONF-800208—2). Dep. NTIS, PC A02/MF A01.

From Tropical meeting on inertial confinement fusion; San Diego, CA, USA (26 Feb 1980).

A two-frame flash x-radiography system has been developed to study target implosion dynamics. It is capable of taking two time separated 3 ns exposure x-ray shadowgrams of a particle beam driven target implosion.

12859 (SAND—79-1949C) **Analytic theory of the spherical electron to ion convertor.** Verdeyen, J.T.; Miller, P.A. (Illinois Univ., Urbana (USA); Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 4p. (CONF-800208—7). Dep. NTIS, PC A02/MF A01.

From Tropical meeting on inertial confinement fusion; San Diego, CA, USA (26 Feb 1980).

Calculations will be presented which indicate that one could, with high efficiency, convert the electron beam energy transported from many pinched diode to ions at a reasonably sized evacuated spherical shell - or a light bulb.

COMPONENT DEVELOPMENT AND MATERIALS TESTING

REFER ALSO TO CITATION(S) 12187, 12888

12860 (CONF-791051—19) **Review of Session C: fusion dosimetry.** Greenwood, L.R. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 10p. Dep. NTIS, PC A02/MF A01.

From 3. ASTM-EURATOM symposium on reactor dosimetry; Ispra, Italy (1 Oct 1979).

Fusion dosimetry includes materials irradiations in a variety of facilities. A general summary of the status of such dosimetry is presented with emphasis on outstanding problems, especially nuclear data needs.

12861 (CONF-7908101—1) **Role of inert gases in first wall phenomena in fusion devices.** Das, S.K. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 15p. Dep. NTIS, PC A02/MF A01.

From Symposium on inert gases in metals; Harwell, UK (8 Aug 1979).

The first wall surfaces of fusion devices will be exposed to bombardment by inert gaseous projectiles such as helium. The flux, energy and angular distribution of the helium radiation will depend not only on the type of device but also on its design parameters. For near term tokamak devices, the first wall surface phenomena caused by helium bombardment that appear to be quite important are physical sputtering and radiation blistering. Examples of these processes for a number of first wall candidate materials are discussed.

While the physical sputtering phenomen is well understood, the mechanism of blister formation is still not fully understood. The various models proposed for radiation blistering of metal during helium bombardment is critically reviewed in the light of most recent experimental results.

12862 (DOE/ET—0065/7) **Damage analysis and fundamental studies. Quarterly progress report, July-October 1979.** (Department of Energy, Washington, DC (USA). Office of Fusion Energy). Nov 1979. 183p. Dep. NTIS, PC A09/MF A01.

Preliminary data are given for each of the following research areas: (1) rotating target neutron source, (2) nuclear data for FMIT, (3) experiments at ORR, (4) helium accumulation neutron dosimetry for the Be(d,n) irradiation environment, (5) FMIT damage parameter sensitivity study, (6) development of the STAYSL computer code, (7) damage production, and (8) damage microstructure evolution and mechanical behavior. (MOW)

12863 (GA-A—15653) **Possible incorporation of a dee-shaped vacuum vessel in Doublet III.** Davis, L.; Rawls, J.M. (General Atomic Co., San Diego, CA (USA)). Nov 1979. Contract AT03-76ET51011. 7p. (CONF-791102—79). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research: San Francisco, CA, USA (13 Nov 1979).

The design of Doublet III allows relative straightforward incorporation of any of a number of possible dee-configuration vacuum vessels that can serve as relevant size tests of reactor regime devices. Configurations simulating those of JET, ETF and INTOR with plasma areas larger than TFTR can be attained with significant physics parameter results. Such modifications to Doublet III could be incorporated into planned upgrade activites with operations beginning in 1984, early enough to influence the designs of ETF and INTOR and test the scaling laws, poloidal coil system, and impurity control systems proposed for these ignition devices.

GENERAL AND MISCELLANEOUS

MANAGEMENT

12864 (AD-A—065650) **USAF-ASEE (1978) summer faculty research program (WPAFB). Volume I. Final report, 1 January 1976-30 September 1978.** Bailey, C.D. (Ohio State Univ. Research Foundation, Columbus (USA)). Nov 1978. Contract F44620-76-C-0052. 515p. NTIS, PC A22/MF A01.

Partial contents are as follows: Regularization of Ill-posed Problems; Unconditionally Stable Second Order Accurate Method for Transonic Flutter Calculations; Large Amplitude Response of Complex Structures due to High Intensity Noise; Synthesis of Manual and Automatic Control Applied to Integrated Fire and Flight Control; Catalytic Flame Stabilization for Aircraft Afterburners; Cadmium Deposition Reactions on Cadmium and Nickel Electrodes by Cyclic Voltammetry; Turbulent Flow Measurements for Sudden Expansion Cylindrical Tube Using Laser Doppler Velocimeter; Design Procedure for High Power Density MHD Generators; Computer-aided Process Planning for Sheet Metal Operations; Feasibility of using the EPR Technique on Detector Grade Silicon; A Simulation Metamodel; Analysis of the GPS Receiver Loss-of-lock Problem; and Physics of Matrix Cathodes.

12865 (BNL—51000) **Brookhaven highlights, July 1976-September 1978.** (Brookhaven National Lab., Upton, NY (USA)). Nov 1979. Contract EY-76-C-02-0016. 214p. Dep. NTIS, PC A10/MF A01.

Some of the most significant research accomplishments during this 27-month period are presented. Although some data are given, this report is primarily descriptive in outlook; detailed information on completed work should be sought from the references cited herein or from the usual sources of physics research information. The report is organized as follows: High-energy Physics (general introduction, physics research, accelerators, ISABELLE); Nuclear and Solid State Physics, and Chemistry; Life Sciences (biology, medicine); Applied Energy Science (energy and the environment, reactor systems and safety, National Nuclear Data Center, nuclear materials safeguards); Support Activities (applied mathematics, instrumentation, reactors, safety and environmental protection); and General and Administrative. 117 figures, 16 tables, 315 references. (RWR)

12866 (COO—5075-7) **Study of preservation of documents at Department of Energy national laboratories. Progress report, June 1, 1979-August 31, 1979.** Warnow, J.N.; Weart, S.R. (American Inst. of Physics, New York). Oct 1979. Contract ER-78-C-02-5075. 5p. Dep. NTIS, PC A02/MF A01.

Record surveying continued at Lawrence Berkeley Laboratory. A six-month period of work at Argonne National Laboratory included studies of records in the Director's Office, records documenting physics and accelerator activities, and particularly files documenting the history of the ZGS. A survey of historical and records management programs at various government agencies with scientific responsibilities was accomplished. A report on this survey was mailed to the project's Advisory Committee, as were reports on field work at Oak Ridge National Laboratory and at Lawrence Berkeley Laboratory, and a guide for the members of the Committee representing scholarly disciplines, to help them prepare statements on the value of historical records at DOE laboratories. Preparations were begun for the Committee's October meeting.

12867 (DOE/AD/7405—3) **1979 national survey of compensation. Paid scientists and engineers engaged in research and development activities.** (Battelle Columbus Labs., OH (USA)). Dec 1979. Contract W-7405-ENG-92. 358p. Dep. NTIS, PC A16/MF A01.

This survey of compensation uses the maturity of age-wage approach, in which salary data are related to years since receipt of degree or chronological age. This report gives the results of the twelfth annual survey, conducted in 1979. Introductory material is given on the sampling plan (survey universe listing, sampling frame, sampling procedures, structure of sample), basic data for survey analysis (establishment data, employee data), entrance rates, trend analysis, geographic analysis, analysis of data (editing of raw data, use of varying axes, arithmetic formulas, median curves), important qualifications concerning survey results, and computation of approximate confidence limits. The bulk of the report contains salary tables of the following types: total survey tables; Bachelor's degree; Master's degree; Doctorate degree; professional degrees; median, curves-supervisory level by degree level, YSBD; nondegreed employees, age; working-as occupation, YSBD; sex, nonsupervisory employees, Bachelor's degree, working-as occupation; trend analysis-five-year identical-company comparisons, median curves; and standard metropolitan statistical area size by establishment size, median curves and census district curves. Employer questionnaire forms are appended. (RWR)

12868 (DOE/TIC—11069) **Phase XIII: the twelfth annual national survey of compensation paid to scientists and engineers engaged in research and development activities in the United States. Final report.** Newborg, J.; Gabel, J.; Beatty, G.H.; Evans, P.; Spurgeon, M.; Hadlock, J. (Battelle Columbus Labs., OH (USA)). 21 Dec 1979. Contract W-7405-ENG-92. 89p. Dep. NTIS, PC A05/MF A01.

This survey utilized the maturity-type design. It obtained information concerning compensation and compensation-related characteristics of both nondegreed and degreed scientists and engineers engaged in research and development. Information was obtained concerning both the employees and employers. The universe specifications encompassed industrial establishments, educational institutions, nonprofit research institutes, federal laboratories, and federally funded research and development centers. The sampling plan was the same as for previous surveys. The sample size was maintained at approximately 300 establishments. The sampling plan incorporated stratification and clustering based upon establishment size in terms of numbers of scientists and engineers employed and size of the Standard Metropolitan Statistical Area in terms of scientists and engineers in the area. Trend analyses, showing changes in salary levels over a five-year period, were prepared. This report describes and discusses the various elements of the survey including survey forms, universe specifications and sampling, survey conduct, data analysis, and data processing. The project report provides not only a description of the survey, but presents information on development work done to improve the data processing procedures. The final section of the report makes recommendations for the conduct of the 1980 survey. 2 figures, 13 tables. (RWR)

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 12391, 12416, 12521, 12666

12869 (ANL/MHD—79-11) **User's guide for GSMP, a General System Modeling Program.** Cook, J.M. (Argonne National Lab., IL (USA)). Oct 1979. Contract W-31-109-ENG-38. 349p. Dep. NTIS, PC A15/MF A01.

GSMP is designed for use by systems analysis teams. Given compiled subroutines that model the behavior of components plus instructions as to how they are to be interconnected, this program links them together to model a complete system. GSMP offers a fast response to management requests for reconfigurations of old systems and even initial configurations of new systems. Standard system-analytic services are provided: parameter sweeps, graphics, free-form input and formatted output, file storage and recovery, user-tested error diagnostics, component model and integration checkout and debugging facilities, sensitivity analysis, and a multimethod

optimizer with nonlinear constraint handling capability. Steady-state or cyclic time-dependence is simulated directly, initial-value problems only indirectly. The code is written in PL/I, but interfaces well with FORTRAN component models. Over the last five years GSMP has been used to model theta-pinch, tokamak, and heavy-ion fusion power plants, open- and closed-cycle magneto-hydrodynamic power plants, and total community energy systems.

12870 (CONF-781108—) **1978 DOE Statistical Symposium.** Davis, H.T.; Prairie, R.R.; Truett, T. (comps.). (Sandia Labs., Albuquerque, NM (USA); Oak Ridge National Lab., TN (USA)). Jul 1979. Contract W-7405-ENG-26. 336p. Dep. NTIS, PC A15/MF A01.

From 4. DOE statistical symposium; Albuquerque, NM, USA (1 Nov 1978).

Separate abstracts were prepared for 13 of the papers given at this symposium. The remaining two have already been cited in ERA, and may be found by referring to the entry CONF-781108— in the Report Number Index. (RWR)

12871 (CONF-781108—, pp 4-29) **Growing trees to analyze high-dimensional data.** Breiman, L. (Tech. Service Corp., Santa Monica, CA). Jul 1979.

From 4. DOE statistical symposium; Albuquerque, NM, USA (1 Nov 1978).

Tools available for extracting information in prediction/classification problems include classical (multilinear regression, parametric nonlinear regression, linear discriminant analysis) and nonclassical (use of interpoint distances, piecewise linear or piecewise polynomial approximations) types. The growing of a classification tree is described; various algorithms, such as AID and CART, are available for growing regression trees. Further work on classification criteria, growing a chemical spectra tree, dealing with overall bias through pruning and cross validation, and the problem of biased variable selection are discussed. 11 figures, 1 table. (RWR)

12872 (CONF-781108—, pp 111-125) **Redundant systems subject to simultaneous failures.** Abramson, L.R. (Nuclear Regulatory Commission, Washington, DC). Jul 1979.

From 4. DOE statistical symposium; Albuquerque, NM, USA (1 Nov 1978).

A redundant system consisting of $n \geqq 1$ identical components subject to independent and simultaneous failures is considered. The system fails only if all n components fail. Assuming exponential failure distributions, probabilities of the two failure modes and the means and variances of the times to failure (unconditional and conditional on simultaneous or independent failures) are calculated. For all $n > 1$, the mean time to a simultaneous failure is always less than the mean time to an independent failure.

12873 (CONF-790902—) **Scientific computer information exchange meeting.** (Department of Energy, Washington, DC (USA). Office of Basic Energy Sciences; California Univ., Livermore (USA). Lawrence Livermore Lab.). 1979. Contract W-7405-ENG-48. 176p. Dep. NTIS, PC A09/MF A01.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

Individual abstracts were prepared for 17 papers in these proceedings. Three additional papers have already been cited in ERA, and these can be located by reference to the entry CONF-790902— in the Report Number Index. (RWR)

12874 (CONF-790902—, pp 24-29) **Particle simulation on the VAP.** Drummond, W.E.; Moore, B.N. (Austin Research Associates, TX). 1979.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

A report on the status of hardware and software development on the VAP is given. The VAP is designed as a floating point vector array processor of considerable power, and will be able to execute large vector programs at high speed in a stand-along mode. Other design features are multiple large, fast data memories with independent data paths to a pipelined arithmetic unit. Four of these memories are vector (serial) memories with a maximum size of 8 million words. There is also a scalar (ram) memory with a total of 1 million words. Practical operation at speeds of 12 Mflops will be possible. A software package is under development which will eventually make it possible to program at the Fortran level. Applications to plasma simulation are discussed. 3 figures, 5 tables.

12875 (CONF-790902—, pp 60-68) **Development of a STAR-100 code to calculate a two-dimensional fast Fourier transform.** Lambiotte, J. (Langley Research Center, Hampton, VA). 1979.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

The development of a computed code to perform a two-dimensional fast Fourier transform (2-D FFT) for real data on the STAR-100 is described. Since the 2-D transform can be computed by performing successive 1-D transforms, the code is built around an existing STAR 1-D FFT subroutine. Much of the complexity of this development effort resulted from the STAR hardware requirements for vectors to be sufficiently long and to reside in contiguous memory locations, from the need to compute the transform of large data sets which can exceed the available central memory of the STAR, and from the desire to take advantage of the real property of the data. These particular requirements are discussed and STAR-100 timing results are presented. 2 figures, 2 tables.

12876 (CONF-790902—, pp 85-91) **Advanced computers and Monte Carlo.** Jordan, T.L. (Los Alamos Scientific Lab., NM). 1979.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

High-performance parallelism that is currently available is synchronous in nature. It is manifested in such architectures as Burroughs ILLIAC-IV, CDC STAR-100, TI ASC, CRI CRAY-1, ICL DAP, and many special-purpose array processors designed for signal processing. This form of parallelism has apparently not been of significant value to many important Monte Carlo calculations. Nevertheless, there is much asynchronous parallelism in many of these calculations. A model of a production code that requires up to 20 hours per problem on a CDC 7600 is studied for suitability on some asynchronous architectures that are on the drawing board. The code is described and some of its properties and resource requirements ae identified to compare with corresponding properties and resource requirements are identified to compare with corresponding properties and resource requirements are identified to compare with corresponding properties and resources of some asynchronous multiprocessor architectures. Arguments are made for programer aids and special syntax to identify and support important asynchronous parallelism. 2 figures, 5 tables.

12877 (CONF-790902—, pp 94-102) **Design considerations for a partial differential equation machine.** Arvind; Bryant, R.E. (Massachusetts Inst. of Tech., Cambridge). 1979.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

Partial differential equation (PDE) simulation provides an attractive area for the application of highly parallel computer systems. The regular and static structures of these problems and the limited data dependencies allow them to be mapped onto a system consisting of many interconnected processors. This paper presents an analysis of a program for simulating the hydrodynamic motion and heat flow in a compressible fluid. On the basis of this analysis, some of the issues in designing programing languages and computer architectures for PDE simulations are discussed. The data flow model of computation is seen to provide an attractive means for managing the complexity of highly parallel systems. Data flow concepts can be applied to relatively simple architectures specifically designed for PDE simulation. 3 figures.

12878 (CONF-790902—, pp 103-114) **Vectorized sparse elimination.** Calahan, D.A. (Univ. of Michigan, Ann Arbor). 1979.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

Vectorizable sparse equation solution algorithms are classified by the matrix structure which they favor. The state of the art for solution of relatively dense systems is then reviewed. A hybrid vector construct is defined for the increasingly common structure of both moderate local marix density and global matrix regularity. Estimates are made of CRAY-1 speedup achievable with this construct. A finite difference matrix is studied as an example. 8 figures, 2 tables.

12879 (CONF-790902—, pp 144-148) **Vectorization techniques for an iterative algorithm.** Brockway, D.V.; Gama-Lobo, F. (Los Alamos Scientific Lab., NM). 1979.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

A major vectorization effort on a large complex hydrodynamics code on the CRAY-1 was recently completed, resulting in a factor of 10 speed increase over the original code on the CDC-7600. To accomplish this required vectorizing an iterative algorithm. Some new techniques were developed to do this: these are described in detail.

12880 (COO—3077-161) **Optimization of horizontal microcode within and beyond basic blocks: an application of processor scheduling with resources.** Fisher, J.A. (New York Univ., NY (USA). Courant Mathematics and Computing Lab.). Oct 1979. Contract EY-76-C-02-3077. 183p. Dep. NTIS, PC A09/MF A01.

Microprogram optimization is the rearrangement of microcode written vertically, with one operation issued per step, into legal horizontal microinstructions, in which several operations are issued each instruction cycle. The rearrangement is done in a way that approximately minimizes the running time of the code. This problem is identified with the problem of processor scheduling with resource constraints. Thus, the problem of optimizing basic blocks of microcode can be seen to be np-complete; however, approximate methods

for basic blocks which have good records in other, similar scheduling environments can be used. In priority list scheduling the tasks are ordered according to some evaluation function, and then schedules are found by repeated scans of the list. Several evaluation functions are shown to perform very well on large samples of various classes of random data-precedence graphs with characteristics similar to those derived from microprograms. A method of spotting resource bottlenecks in the derived data-precedence graph enables one to obtain a resource-considerate evaluation function, in which tasks which contribute directly to or precede bottlenecks have their priorities raised. The complexity of the calculations necessary to compute the lower bound was greatly reduced. A method is suggested for optimizing beyond basic blocks. Groups of basic blocks are treated as if they were one block; the information necessary to control the motion of tasks between blocks is encoded as data-precedence constraints on the conditional tasks. Long paths of code can thus be optimized, with no back branches, by the same methods used for basic blocks. 9 figures, 6 tables.

12881 (ORNL/TM—7021) **User's guide to program GFTMOV: a computer program to access and format a GIFTS 4B UDB into a data base for the MOVIE. BYU Program.** Gray, W.H. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 54p. Dep. NTIS, PC E02/MF E02.

A program, GFTMOV, that formats data obtained from a GIFTS version 4B Unified Data Base (UDB) into a form suitable for MOVIE.BYU is described. Three sample problems are presented, as well as a discussion of the FORTRAN program. 18 figures, 2 tables.

12882 (SAND—78-1680) **Scientific computing at Sandia Laboratories: a long-range plan.** Lemke, P. (Sandia Labs., Albuquerque, NM (USA)). Nov 1979. Contract EY-76-C-04-0789. 85p. Dep. NTIS, PC A05/MF A01.

Major inadequacies and problems have developed in the present scientific computer complex at Sandia Laboratories, Albuquerque (SLA). This plan proposes to correct these inadequacies with a general concept whose implementation is specific. The concept presented here for meeting the computational needs of SLA is expected to guide the architectural design of the CCF for an extended period of time. The implementation of this concept is subject to change as installation progresses. This plan reflects the current state of technology, and, as new technology is developed, the plan will be modified to use innovations. This document fulfills two requirements: to provide management and users of scientific computing with a preliminary description of the facilities and elements of the proposed new scientific computing complex, and to provide the designers and implementers of the complex a basic system design that can be expanded as each area of the plan evolves. 17 figures, 1 table.

12883 (SAND—79-0579) **CDC6600/7600 subroutine for Bessel functions K/sub ν/(x), $x > 0$, $\nu \geq 0$.** Amos, D.E. (Sandia Labs., Albuquerque, NM (USA)). Dec 1979. Contract EY-76-C-04-0789. 14p. Dep. NTIS, PC A02/MF A01.

Formulae for K/sub ν/(x) and K/sub $\nu+1$/(x) are implemented on intervals $0 < x \leq 2$, $2 < x < 17$, $x \geq 17$ and $-1/2 \leq \nu < 1/2$ to start forward recursion for N member sequences K/sub $\nu+k-1$/(x), $k = 1, \ldots, N$. On $0 < x \leq 2$ a recursive form of the power series is used, while the backward recursive Miller algorithm is implemented for the confluent hypergeometric representation on $2 < x < 17$. For $x \geq 17$, K/sub ν(x) and K/sub $\nu+1$(x) are computed from the asymptotic expansion for $x \to \infty$. If the initial order ν is larger than 35, the sequence is started by computing two members with the uniform asymptotic expansion for $\nu \to \infty$. Overflow and underflow tests are made on the leading term of the uniform expansion when appropriate. An option for exponential scaling is also provided.

12884 (SAND—79-1825) **Quadrature subroutines for splines and B-splines.** Amos, D.E. (Sandia Labs., Albuquerque, NM (USA)). Dec 1979. Contract EY-76-C-04-0789. 12p. Dep. NTIS, PC A02/MF A01.

The B-spline package of De Boor numerically manipulates B-splines in a variety of ways. Notably absent from the package are routines for integrating B-splines. To cover this deficiency BSQUAD, PPQUAD, BFQUAD, and PFQUAD for integrating splines and B-splines were constructed and are described herein. BSQUAD accepts the B-representation in terms of the knot array T(•), the coefficient array BCOEF(•), the number of coefficients N, and the order K to compute integrals on subintervals of $T(K) \leq X \leq T(N+1)$. Distinct knots partition the interval of integration so that polynomial integration by a Gauss quadrature formula can be implemented. The piecewise polynomial (PP) representation, although not preferred over the B-representation for solving problems, is sometimes needed, and the De Boor package has a routine to make the conversion. This PP form is accepted by PPQUAD, which sums polynomial evaluations of integrals on the partition. More general integrals for the product of a function f(x) and a B-spline are computed similarly in subroutines BFQUAD and PFQUAD using a quadrature routine with error control and a code structure similar to that in BSQUAD and PPQUAD.

12885 (SAND—79-2284) **UCMD92: mass properties analysis user guide.** Malloch, J.E. (Sandia Labs., Albuquerque, NM (USA)). Dec 1979. Contract EY-76-C-04-0789. 55p. Dep. NTIS, PC A04/MF A01.

The use of a mass properties (weight, volume, area, center of gravity, moments and products of inertia) analysis computer program implemented on the Applicon 3D Graphics System (AGS/880) is presented. 38 figures, 3 tables.

12886 (SAND—80-8201) **DIFFUSE: a code to calculate one-dimensional diffusion and trapping.** Baskes, M.I. (Sandia Labs., Albuquerque, NM (USA)). Jan 1980. Contract EY-76-C-04-0789. 20p. Dep. NTIS, PC E01/MF E01.

This document is intended to briefly acquaint the reader with the computer code DIFFUSE. DIFFUSE may be used to calculate the one-dimensional diffusion, and trapping of atoms in a material under general initial, source, and boundary conditions. The document includes a description of the physical model, code input and output format, three typical sample problems and their output, a listing of the code, and the control cards needed to use DIFFUSE at Sandia Laboratories, Livermore.

12887 (UCID—17277) **GRAY: a program to calculate gray-body radiation heat-transfer view factors from black-body view factors.** Wong, R.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Jun 1976. Contract W-7405-ENG-48. 30p. Dep. NTIS, PC A03/MF A01.

Program GRAY is written to perform the matrix manipulations necessary to convert black-body radiation heat-transfer view factors to gray-body view factors as required by thermal analyzer codes. The black-body view factors contain only geometric relationships. Program GRAY allows the effects of multiple gray-body reflections to be included. The resulting effective gray-body factors can then be used with the corresponding fourth-power temperature differences to obtain the net radiative heat flux. The program is written to accept a matrix input or the card image output generated by the black-body view factor program CNVUFAC. The resulting card image output generated by GRAY is in a form usable by the TRUMP thermal analyzer.

12888 (UCID—18484) **URLIB: a subroutine library for writing utility routines.** (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Nov 1977. Contract W-7405-ENG-48. 169p. Dep. NTIS, PC A08/MF A01.

The Utility Routine LIBrary of the Magnetic Fusion Energy Computer Center is described. It is the result of an attempt to standardize all utility routines by writing subroutine modules that can be used to make future utility routines. The URLIB writeup describes how to write utility routines that are efficient, easy to use, and standardized in appearance. Sections are included on using URLIB, obtaining files from URLIB, and documentation standards. All URLIB subroutines are described. (RWR)

12889 (UCRL—82976) **Automatic data channel calibration and noise identification.** Nesbit, E.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Oct 1979. Contract W-7405-ENG-48. 30p. (CONF-791053—2). Dep. NTIS, PC A03/MF A01.

From Shock and vibration symposium; Colorado Springs, CO, USA (16 Oct 1979).

The Computer System Applications group at Lawrence Livermore Laboratory is developing an interactive computer-run control, calibration, and data acquisition system for its dynamic test facility. This paper briefly describes this system, derives the parameter identification equations, and discusses the design and implementation of the program to perform automatic calibration and 60, 120, and 180 Hertz noise identification on the data acquisition and control feedback channels. 5 figures, 1 table. (RWR)

12890 **WORKER, a program for histogram manipulation.** Bolger, J.E.; Ellinger, H.; Moore, C.F. (Los Alamos Scientific Lab., NM (USA)). *Comput. Phys. Commun.;* **16**: No. 3, 345-361(Mar 1979).

A set of programs is provided which may link to any user-written program, permitting dynamic creation of histograms as well as display, manipulation and transfer of histogrammed data. With wide flexibility, constants within the user's code may be set or monitored at any time during execution.

12891 **Comments on "Nonstationary assumptions for Gaussian models in images".** Trussell, H.J.; Kruger, R.P. (Los Alamos Scientific Lab., NM). *IEEE Trans. Syst., Man, Cybern.;* **SMC-8**: No. 7, 579-582(Jul 1978).

Evidence is reviewed suggesting that a Laplacian probability density function constitutes a better model for high-pass filtered imagery than the Gaussian model postulated in earlier work. In addition, it is shown that this discrepancy does not either seriously weaken the applicability of this class of images to a major image

restoration method or challenge any other basic conclusions of the previous work. 2 figures.

12892 Sectioned methods for image restoration. Trussell, H.J. (Los Alamos Scientific Lab., NM); Hunt, B.R. Contract W-7405-ENG-36. *IEEE Trans. Acoust., Speech, Signal Process.;* **ASSP-26**: No. 2, 157-164(Apr 1978).

Locally adaptive image processing methods are constructed by sectioning the image and applying a modified MAP restoration algorithm. These local algorithms are shown to be effective in processing nonstationary images. The algorithms can work in both signal-independent and signal-dependent noise. The gains achieved by local and signal-dependent processing are analyzed. 13 figures.

12893 ALPS: classes of stable and semipositive matrices. Berman, A.; Ward, R.C. (Union Carbide Corp., Oak Ridge, TN). *Linear Algebra Its Appl.;* **21**: 163-174(1978).

Various degrees of stability and semipositivity for real square matrices are characterized and interrelated. The standard conditions for three major classes of matrices are made both stronger and weaker, and the resulting classes are examined. The major classes are diagonally stable, stable, and semipositive matrices, denoted by A, L, and S, respectively. Their relationship to the classes of matrices whose principal minors are positive (denoted by P) and non-negative (denoted by P_0) is also presented. 2 figures.

12894 Partial realization of invariant system descriptions. Candy, J.V. (Univ. of Florida, Gainesville); Warren, M.E.; Bullock, T.E. *Int. J. Control;* **28**: No. 1, 113-127(1978).

The partial realization of a finite Markov sequence from the Hankel array for linear, constant, multidimensional systems is considered. It is shown that the algorithm to extract the invariants of Popov from this sequence possesses some attractive nesting properties; i.e., the algorithm processes only the new data and augments these results to the previous solution. It is shown, not only how to determine the minimal partial realization from a fixed number of Markov parameters, but also how to describe the entire class of partial realizations. In addition, a new recursive technique is presented to obtain the corresponding class of minimal extensions.

12895 Subtrees of a tree that form a Koenig system. Slater, P.J. (Sandia Labs., Albuquerque, NM). Contract AT(29-1)-789. *Ars Comb.;* **4**: 271-283(1977).

If T is a tree with subtrees $T_1,T_2,...,T/sub\ p/$ whose vertex sets are $V(T_1),V(T_2),...,V(T/sub\ p/)$, then earlier results have described when $F = [V(T_1),V(T_2),...,V(T/sub\ p/)]$ will be a Menger system. Here, conditions for F to be a Koenig system are examined. 1 figure.

INFORMATION HANDLING

REFER ALSO TO CITATION(S) 12438, 12454, 12669

12896 (BNL—51071) **DOE Interlaboratory Working Group for Data Exchange (IWGDE). Progress report, October 1978.** Benkovitz, C.M. (ed.). (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 25p. Dep. NTIS, PC A02/MF A01.

This report describes the activities of the DOE Interlaboratory Working Group for Data Exchange (IWGDE) as of October 1978. The IWGDE was created in response to an evident need for increased sharing of resources among ERDA installations. During fiscal year 1976 it was supported through funds allocated to the Energy Analysis and Assessment Programs of seven multipurpose ERDA national laboratories. During fiscal years 1977 and 1978 it was supported by direct funding from the Division of Environmental Impacts, Office of Technology Impacts, Department of Energy. Principal accomplishments included the interlaboratory exchange of socioeconomic, environmental, demographic, and energy-related data bases; liaison development through interlaboratory meetings; definition and partial implementation of a computer-independent standard for exchange of data; initial definition of a Geographic Exchange Standard and Primer, and a first attempt at the definition of content and format for a set of DOE Reference Data Bases.

12897 (CONF-781108—, pp 31-49) **Energy information validation: a status report.** Moses, L.E. (Department of Energy, Washington, DC). Jul 1979.

From 4. DOE statistical symposium; Albuquerque, NM, USA (1 Nov 1978).

Experiences of the Energy Information Administration are recounted. Its tasks involve verification of information submitted by respondents, checking the integrity of data collection systems, and participating in the establishment of new systems (rolling review of all systems, validation of models, validation of publications). Lessons learned during the first year are summarized. A validation report for a single data collection system is given in an appendix. (RWR)

12898 (NUREG/CR—1010) **Evaluation of docket files for terminated source material licenses.** Holoway, C.F.; Lantz, P.M.; Dickson, H.W. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 60p. (ORNL/NUREG/TM—342). Dep. NTIS, PC A04/MF A01.

Terminated source material licenses from docket files of the Nuclear Regulatory Commission (NRC) have been evaluated with respect to the potential for residual radiological health problems. Some 8,275 source material docket files were sent from the Federal Repository for NRC to Oak Ridge National Laboratory for evaluation. An NRC printed inventory of terminated source material licenses was sent separately and input to a computer file for ready access. The files were inventoried and a methodology was developed for evaluation of these files. The methodology included development of a combined analysis/computer input form. Pertinent data were abstracted from each file, placed on this form, and entered into a separate private-access computer file. At the same time, analysts using screening criteria made a preliminary categorization of the files. All files categorized initially as potential radiological health problems were reviewed in depth to arrive at a final categorization. Criteria for judgment included quantities of source material (uranium and/or thorium) going to and leaving the site in question during the operational lifetime of the site, disposition of source material not leaving the site, types of operations carried on at the site during the licensed period, and the physicochemical forms of products and wastes involved. In the final analysis, 193 dockets were identified as having potential for residual radiological health problems.

CIVILIAN DEFENSE

12899 (ORNL—5546) **Instrumentation requirements for radiological defense for crisis relocation planning. Final report.** Haaland, C.M.; Horwedel, B.M. (Oak Ridge National Lab., TN (USA)). Dec 1979. Contract W-7405-ENG-26. 97p. Dep. NTIS, PC A05/MF A01.

Estimates are made of radiological instrument requirements for the US population to provide guidance for protection from the hazards of nuclear radiation from a nuclear attack. Much of the population is assumed to be relocated from risk areas according to Crisis Relocation Planning (CRP). The population is assumed to be distributed in shelters as follows: 34% in shelters in the National Shelter Survey (NSS); 17% in facilities upgraded for fallout protection during a crisis period (CRP facilities); 42% in home basements; and 7% in expedient shelters. To prevent overexposure to nuclear radiation on emergence from shelters and to reduce long-term carcinogenic and genetic effects, about 35 million dosimeters, 9 million survey meters, and 10 million chargers would be required.

CORPORATE INDEX

In the Corporate Index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

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DOE Energy Information Data Base: Corporate Author Entries (TID-4585) is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

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AB Strangbetong, Stockholm (Sweden)
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Responses of selected Chesapeake Bay fish and invertebrate species to natural and artificial thermal increases - a review of the literature, 5:12639 (PB—290596)

Aerodyne Research, Inc., Bedford, MA (USA)
Initiation phenomena in pulsed chemical lasers. Final report 8 August 1977-30 September 1978, 18 August-17 November 1978, 5:12290 (AD-A—065885)

Aerospace Corp., El Segundo, CA (USA)
Measurements of insolation variation over a solar collector field, 5:11428 (ATR—79(7747)-2)

Aerospace Corp., El Segundo, CA (USA). Energy and Resources Div.
Fort Hood solar total energy project. Technical support and systems integration. First semiannual report, May 1-October 31, 1978, 5:11641 (ALO—4271-01)

Aerospace Corp., El Segundo, CA (USA). Ivan A. Getting Labs.
Low cost solar array project: composition measurements by analytical photon catalysts. Third quarterly report, April 1-June 30, 1979, 5:11453 (DOE/JPL/955201—3)
Low Cost Solar Array Project: composition measurements by analytical photon catalysis. Quarterly report, 1 November-31 December 1978, 5:11458 (N—79-16367)

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The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

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CONF-780612-		(Symposium on advances in radiation protection monitoring, Stockholm, Sweden, 26-30 Jun 1978)
10	5:12790	*See* PNL-SA-6603
CONF-780622-		(ANS annual meeting, San Diego, CA, USA, 18-23 Jun 1978)
83	5:11869	*See* PNL-SA-6921
CONF-7806170-		(4. Kentucky coal refuse disposal and utilization seminar, Pineville, KY, USA, 6-7 Jun 1978)
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CONF-780798-	(Asia-Pacific energy studies conference, Honolulu, HI, USA, 26-28 Jul 1978)	
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10	5:11911	*See* INIS-mf-520?
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14	5:12177	*See* PNL-SA-7229
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CONF-7903102-	(8. international colloquium on group theoretical methods in physics, Kiriat Anavim, Israel, 25 Mar 1978,-29 Mar 1979)	
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6	5:11961	*See* PNL-SA-7669
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13	5:12609	*See* LBL-10109
14	5:12610	*See* PNL-SA-7502
CONF-7905121-	(Intercity passenger transport conference, Ottawa, Canada, 17-18 May 1979)	
	5:12106	Science Council of Canada, 100 Metcalfe St., Ottawa, Ontario
CONF-7905131-	(American Society of Mechanical Engineers radioactive waste management course, Alexandria, VA, USA, 21-25 May 1979)	
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3	5:11347	*See* LBL-9426
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1	5:12669	*See* LBL-9636
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7	5:12315	*See* SAND-79-1479C
CONF-790709-		(VII international AIRAPT conference, La Creusot, France, 30 Jul-3 Aug 1979)
19	5:11173	*See* UCRL-82731
CONF-790711-		(International symposium on underground disposal of radioactive wastes, Otaniemi, Finland, 2-6 Jul 1979)
4	5:11354	*See* PNL-SA-7243
CONF-790743-		(Symposium on heavy ion physics from 10-200 MeV/A, Upton, NY, USA, 16-20 Jul 1979)
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3	5:12738	*See* SLAC-PUB-2433
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9	5:12726	*See* SLAC-PUB-2442
11	5:12724	*See* SLAC-PUB-2419
13	5:12735	*See* FERMILAB-Conf-79/87-THY
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1	5:12540	Dep. NTIS, PC A03/MF A01
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1	5:12861	Dep. NTIS, PC A02/MF A01
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3	5:12246	*See* ISM-251
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3	5:12657	Dep. NTIS, PC A02/MF A01
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10	5:12828	Dep. NTIS, PC A03/MF A01
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12	5:12072	Dep. NTIS, PC A02/MF A01
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12	5:11679	*See* UCRL-83650
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2	5:12710	*See* LBL-9992
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3	5:12624	Dep. NTIS, PC A02/MF A01
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1	5:12516	Dep. NTIS, PC A02/MF A01
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6	5:12343	*See* BNL-27128
7	5:12326	*See* BNL-27129
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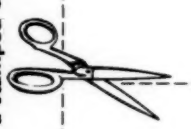

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